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PHYSICS.—*Adsorption and pycnometry.*[1] P. G. NUTTING, U. S. Geological Survey.

It is well known that adsorbed films may profoundly affect the apparent density, permeability and other physical properties of very finely divided solids. Adsorbed water chokes the pores of clays and obstructs the percolation of water through them. Bleach clays bleach by means of their selective adsorption of the various constituents of the fluids in contact with them. That adsorption is of several kinds and many degrees is shown by the diversity of weight-temperature relations. It seemed worth while to investigate the possibilities of pycnometry in resolving this group of problems, using a number of conditioning temperatures and pycnometric fluids in the study of some highly adsorbing clays. Since the density changes are slight, the utmost precision is necessary.

Weighings to one part in ten thousand offer no difficulty. The volume of any good pycnometer is definable with nearly as great precision, and most of the other errors are controllable with careful work. The chief difficulty lies within the sample itself; in interpretation of its moisture content, the expulsion and solution of air and moisture by the pycnometer fluid and the adsorption of pycnometer fluid on grain surfaces.

Definite volumes are best secured and evaporation is minimized with pycnometers that use an optically flat cover, such as the bottle form of Johnston and Adams[2] or the flat dish form of the writer.[3] The latter form has the added advantage that it is also useful for determining lump densities. Fair results may be obtained with an ordinary form of pycnometer having a ground-in stopper if it is well constructed. Walls too thin to withstand wiping pressures, poorly ground-in stoppers and grooves between stopper and neck are common defects.

[1] Published by permission of the Director, U. S. Geological Survey. Received December 11, 1935.
[2] Jour. Am. Chem. Soc. 34: 566. 1912.
[3] Bull. Am. Assoc. Pet. Geologists 14: 1344. 1930.

Errors due to temperature changes during manipulation cannot be obviated entirely but may be made negligible if direct contact between pycnometer and the fingers is avoided and if the work is done in a room with temperature constant for several hours to within a few tenths of a degree. Pycnometers with built-in thermometers and bath thermostats for bringing the pycnometer to a fixed temperature introduce more errors and uncertainties than they eliminate, in the writer's opinion. The method preferred by him is to choose a time of day for making weighings when the room temperature has changed very little for several hours and is changing at a rate less than one-fifth degree per hour. The pycnometer volume is freshly determined (with water) just before and just after each determination of grain volume and of density of pycnometer fluid.

The pycnometer fluid. The prime essential of a pycnometer fluid is its wetting power—its ability to expel air. Further it should not dissociate or polymerize during use, nor should it combine with or be adsorbed on the surface of the material under test. No one fluid can be used on all materials and only a few are entirely satisfactory for any material. Water is fairly suitable for finding the volume of a paraffin-coated lump but it is one of the worst possible choices for such granular materials as clays and soils, as it tends to be adsorbed, and to emulsify air instead of completely expelling it. Some minerals appear to take up hydroxyl and hydrogen unequally, thus decomposing water.

The aromatics and chlorinated compounds, which are least adsorbed and "cracked" by clays and soils, appear to have the widest range of application as pycnometer fluids. Highly refined and stabilized paraffines, such as the laxative mineral oils, are cracked by many active clays, but the chlorinated compounds are not. Dichloroethyl ether ("chlorex"), tetrachloroethane and the mono-, di- and trichlorobenzenes are quite satisfactory in this respect. The writer's favorite pycnometer fluid for years has been tetrahydronaphthalene ("tetralin"). This and the chlorinated compounds just mentioned are but slightly adsorbed on soil grains, they are powerful wetting agents, they decompose or polymerize very little in use and they disturb existing hydrates very slightly if at all. They have low vapor pressures, moderate densities, and moderate thermal expansions.

Preparation of sample. The first step is to define the substance whose mean density it is desired to measure. Practically every sample contains adsorbed air and moisture, both of which reach significant proportions when the specific surface is large. Soil and clay samples

may contain organic matter, oil sands contain oil and tarry adsorbed films, textile fibers have gummy coatings. A proper pycnometer fluid will remove the air. Moisture may be removed by room drying, desiccation, oven drying, or ignition, as the case may be. Free oil may be removed by washing, adsorbed oil and organic matter only by ignition or by "wet combustion" with chromic acid. When grain and lump densities are to be determined to find porosity, obviously the same contaminations must be removed for both determinations.

Incomplete air removal of course means a first order error in density determinations. Even with a powerful wetting fluid all the air cannot be expelled from a clay in a reasonable time without fairly fine grinding. Grinding to a powder to pass a 300 mesh screen may increase errors due to adsorption because the specific surface is thereby increased. Experimental evidence indicates that interstitial air is expelled in an hour or less, whereas trapped internal air diffuses out of 0.1 mm. grains and escapes only after several hours. For the most precise work on the finest grained clays, the 150 mesh material (sieve openings 0.1 mm.) is weighed and wet down with tetralin or chlorex, then left over night before the final stirring, filling, and weighing. Density determinations that are repeatable to a few parts in ten thousand may be obtained by this method.

Another first order factor is the proportion of water in the sample. If attention is to be centered on the density of the grains free from any given variety of water (such as absorbed, adsorbed, or osmotic water), such water should be removed previous to the density determination. If this is not done the density found will obviously be merely that of the complex involved, including the water. The nature of the water will usually have to be determined by special tests, if such determination is possible. It is well known that substances that form hydrates tend to lose their water abruptly at some definite temperature or vapor pressure, whereas substances like clays and soils lose it continuously up to the point at which essential water is lost. Owing to lack of further criteria the non-essential water in these substances is generally considered to be adsorbed water. The writer feels that density determinations even on materials containing more or less adsorbed water may throw some light on the phenomena of adsorption, and this in turn on the true density of the mineral grains. Weight-humidity and weight-temperature relations for a number of clays are given in one of the author's papers.[4]

As an illustration of density differences due to the condition of the

[4] U. S. Geol. Survey Circular 3: 24–38. 1933.

sample, a +150 mesh fraction of a local soil showed a mean grain density of 2.428 when in equilibrium with room air at 27°C. and 20 per cent humidity and 2.650 after drying at 160°C. The ignited material had a density of 2.405. The room-dry density includes considerable adsorbed water while the low density after ignition probably represents material that has lost its organized structure and that may be even slightly sintered together. Conditioning of the sample at 160°C. for at least two hours is standard practice with the writer. This expels all loosely held moisture without breaking down the more stable hydrates or carbonates. For material that contains considerable cellulose or other organic matter, probably 140°C. would be better. For shales, 200°C. is preferred.

Adsorption of pycnometer fluid on grain surfaces introduces a second-order error in density determinations by making the apparent volume too small and the density too great, because the adsorbed layer is condensed to above-normal density. As this adsorptive force decreases rapidly with distance from the adsorbing surface, it is not practicable to correct for it.

Water or other matter that is adsorbed on mineral grains must obviously yield a density for the material as a whole that will be lower than that of grains with no adsorbed matter. Part or perhaps all of this adsorbed moisture may be removed by heating. An experiment with quartz may illustrate the point. A piece of crystal free from inclusions was crushed to about 3 mm. and a portion of this further crushed to just pass a 300 mesh sieve. The coarse lumps and the fines, after ignition, gave the densities 2.6440 and 2.6438 gm/cc., respectively (in water). Before ignition, however, the fines exposed over night to room conditions (temperature 25° and humidity 52 per cent), gave 2.6342. A weight-temperature curve run on the raw fines showed 1.0061 at 25°, 1.0049 at 100°, 1.0034 at 200°, and 1.0018 at 400°, relative to base weight at 800°. If 6.1 mg. of water per gram of sample is spread over a specific surface of 400 cm.^{2}/gm. (calculated from size of grains) the adsorbed layer would be 15×10^{-6} cm. or over one hundred molecular layers thick. More direct determinations of this thickness[5] make it 5×10^{-6} cm. (0.05μ) for the inner firmly adsorbed layer.

On glass the adsorption of water is relatively small. Some internal water, however, is expelled by heating to about 500°C. Coarse and fine (300 mesh) pyrex powder showed densities (in water) of 2.2375 and 2.2349 gm/cc. After heating to 480° the fines showed a density

[5] *Adsorptive force of silica for water.* Jour. Phys. Chem. 31: 531. April, 1927.

of 2.2445 gm/cc. A thermal dehydration curve indicated a loss in weight of 0.3 per cent between 50° and 480° but with a pronounced shoulder on the curve between 160° and 240°C. The internal water removed by heating appears to be restored readily for the density after heating is high.

The effect of thermal conditioning and of pycnometer fluid on density determinations is shown by the following results on typical Florida fuller's earth. The material was from a block of light gray clay that had been room-dried 4 years and freshly ground to 150 mesh. The lump density was 1.0607, voids 52.9 per cent. Grain densities were determined with both water and dichloroethyl ether ("chlorex"), relative weights in a platinum crucible. Room condition was 32°C., 75 per cent relative humidity.

TABLE 1.—DENSITIES OF FULLER'S EARTH

	At room conditions	Dried at 160°C.	Product after heating to 800°C.
Mean grain density in chlorex	2.2513	2.4993	2.6008 gm/cc.
Mean grain density in water	2.2567	2.5903	2.6005 gm/cc.
Difference (Hydration ?)	0.0054	0.0910	0.0003(?) gm/cc.
Observed relative weights	1.2400	1.1511	1.0000
Calculated relative volumes	1.4321	1.1973	1.0000

Ignition at 800°C. rendered the product insensitive to water. Apparently, the preferential adsorption of water, as compared with chlorex, in the pycnometer, added 5.4 mg/cc. to the clay in equilibrium with room conditions, and 91.0 mg/cc. to that conditioned at 160°C. Neglecting a very slight oxidation of iron at 800°, the sample is 24 per cent heavier at room temperature and 15 per cent heavier at 160° than at 800°, because of adsorbed, osmotic, and essential water. The grain volumes are 43.21 per cent greater at room conditions and 19.73 per cent greater at 160° than at 800°. Uncertainties are believed to be at most 3 units in the last place. It should be stated, however, that the figures in the last column are not exactly comparable to those in the second and third columns, as essential water has been driven off at 800° and the material may have been broken down to an indefinite aggregate.

In order to study possible effects of adsorption further, a set of observations similar to the above was made with an imported highly activated acid-treated bentonite, and using gasoline as one pycnometer fluid. This is a finely-ground clay of high bleaching power. The gasoline used had just been liberally treated with bleaching clay

to remove gums, olefines, and other stray constituents. The clay was room-conditioned to 30° and 70 per cent relative humidity.

TABLE 2.—DENSITIES OF HIGHLY ACTIVE CLAY

	At room conditions	Dried at 160°C.	Product after heating to 800°C.
Mean grain density in chlorex	2.2322	2.4218	2.3841 gm/cc.
Mean grain density in water	2.0249	2.4304	2.6504 gm/cc.
Mean grain density in gasoline	2.2242	2.4508	2.3915 gm/cc.
Observed relative weights	1.1623	1.0739	1.0000
Calculated relative volumes	1.2414	1.0571	1.0000

At room conditions this clay held a large amount of water on grain surfaces, but at 160° the greater part of this water had been driven off. The ignited clay had evidently lost practically all of its internal or essential water. Gasoline was adsorbed a little, as compared with chlorex, on the ignited sample but was adsorbed considerably more on that conditioned at 160°. This clay turned a dark brown in a few minutes owing to cracking and to adsorption of cracked portions of the gasoline. An adsorbed layer of gasoline 0.1μ deep on this clay would add about 5 mg. per gram of clay. The decreased density at 800° indicates loss of essential water, and possibly some sintering.

The pycnometer method may be used to study adsorption but it is tedious and troublesome and less satisfactory than direct first-order methods. However, the pycnometer may become a useful tool of research in investigating changes in grain volume on hydration and dehydration, in distinguishing between internal and external water, and in determining pore size in dehydrated crystals.

BOTANY.—*New and noteworthy mosses from Jamaica.*[1] EDWIN B. BARTRAM, Bushkill, Pennsylvania.

The very extensive moss collections made by C. R. Orcutt during his residence in Jamaica during the years 1927–1929 have provided the material for the following list. The record includes only descriptions of the new species, along with pertinent notes on unusual species that are either rare or new to the island.

During his stay in Jamaica Mr. Orcutt sent me parcels of small specimens from time to time, which were determined and reported upon. After his untimely death in Haiti in 1929 his enormous collections were sent to the United States National Museum. The mosses were subsequently segregated and transmitted to me for study. The

[1] Received August 15, 1935.

task of organizing and labelling such a mass of material has proved an onerous one. With the idea of making available the more important information, I have prepared the present paper. The type collections of the new species are in the United States National Herbarium and my own herbarium.

I am grateful to Dr. W. R. Maxon for his help in separating the mosses from the general collection of lower cryptogams with which they were mixed, and also for a nearly complete record of localities and dates which provides data for numerous collections that otherwise would have been of little value.

FISSIDENTACEAE

Fissidens (Aloma) **imbricatus** E. G. Britt. & Bartr., sp. nov. Fig. 1.

Autoica. Caules gregarii vel dense caespitosi, 5–10 mm. alti, contorti, ramosi, densifolii. Folia dense imbricata, rigida, superne anguste lanceolata,

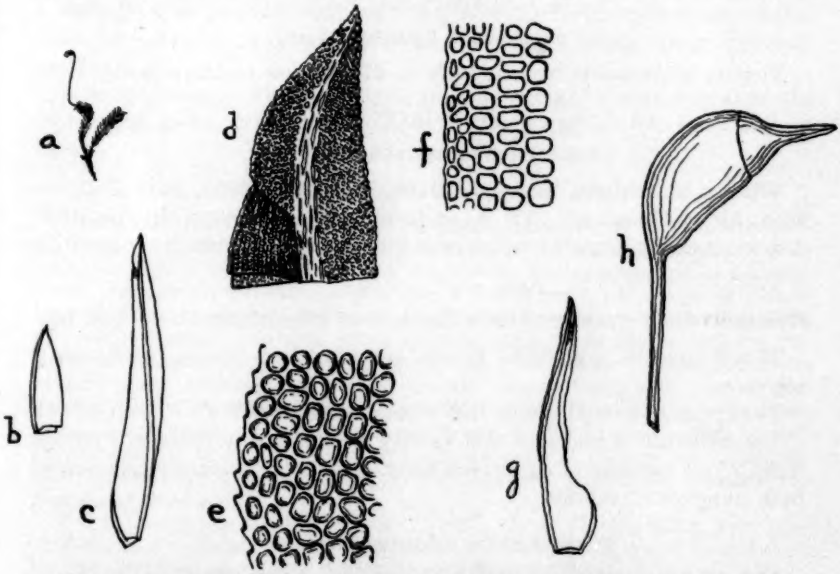

Fig. 1.—*Fissidens imbricatus* E. G. Britt. & Bartr., sp. nov.: *a*, plant ×1; *b*, lower leaf ×22; *c*, upper leaf ×22; *d*, apex of upper leaf ×160; *e*, cells of apical blade and margin ×400; *f*, cells of duplicate blade and margin ×400; *g*, perichaetial leaf ×22; *h*, capsule ×22.

acuta, ad 2 mm. longa; lamina dorsalis angustissima, supra basin enata, inferne minuta; costa subflexuosa, percurrens; margines ubique elimbati, minute crenulati; cellulae superiores hexagonae, circa 10μ, turgidae, parietibus incrassatis, marginales minores, basilares majores, laevissimae, ad 16μ. Seta geniculata, rubra, ad 9 mm. longa; theca inclinata vel arcuata, asym-

metrica, deoperculata circa 0.75 mm. longa; operculum rostratum; peristomii dentes 0.33 mm. longi, fissi; sporae laevissimae, 10–13μ.

TYPE: Schwallenburgh, St. Anne's Parish, Dec. 8, 1927. *C. R. Orcutt* 3942a.

Similar to the rare *F. petrophilus* Sull., but differing in the curled and recurved proliferous stems, longer setae, and inclined or arcuate capsules.

DICRANACEAE

Campylopus Oerstedianus (C.M.) Mitt.

Blue Mountain Peak, nos. 5378 and 5380c.

These collections correspond very well with the description of this species in having the costa merely ribbed on the back and in the poorly developed alar cells. As the ubiquitous *C. introflexus* is a strongly composite species, with innumerable variations, I cannot help feeling somewhat skeptical about the validity of *C. Oerstedianus* as a specific concept.

CALYMPERACEAE

Syrrphodon ligulatus Mont.

Vicinity of Arntully, Nov. 1, 1928, no 6784a. New to Jamaica.

POTTIACEAE

Anoectangium incrassatum Broth.

Vicinity of Arntully, nos. 2779, 3116, 3872, 6755, 6995; Moy Hall, no. 6888; Abbey Green, alt. 5000 ft., on bank; vicinity of Farm Hill, no. 3420. A distinct endemic species which seems to be fairly common, to judge from number of collections.

Hymenostylium glaucum (C.M.) Broth. var. **cylindricum** Bartr. var. nov.

Theca anguste cylindrica, leniter curvata, saepe microstoma, aetate nigrescens.

TYPE: Concrete wall, Farm Hill Works, May 3, 1928, *C. R. Orcutt* 5461.

The cylindric capsules in this variety are noticeably different from the short, ovoid capsules of the typical form. Both are abundantly represented from numerous localities.

Trichostomum sublamprothecium Par.

Moy Hall, no. 6880; vicinity of Arntully, nos. 6791, 7066; Abbey Green, nos. 5170a, 5249a; Farm Hill Works, no. 5455b. The collections grouped here are all similar in having the peristome teeth deeply inserted and free below (not united in a basal membrane as in *T. jamaicense*). The setae are yellow.

Tortella mollissima Broth. (ined.)

Near Sweetwater, St. James' Parish, nos. 2199a, 2201. This species is not included in the Pflanzenfamilien, and is evidently undescribed. It was

found named in a series of mosses collected by C. A. Purpus near Zacuapan, Mexico, which was sent to me from the University of California. Subsequent records from Cuba and Guatemala indicate that it has a rather wide distribution in the Caribbean regions.

Barbula orizabensis C.M.

Barbula recurvicuspes C.M.

Vicinity of Arntully, no. 6900.

This collection is representative of a considerable series from various localities. It is identical in every way with *B. orizabensis* from Mexico. I have not seen the type of *B. recurvicuspes*, but there is surely nothing in the description to indicate any distinction.

Desmatodon Sprengelii (Schwaegr.) Williams

Balaclava, on concrete wall, no. 625a; Phillip's Field, on bank, no. 1840a; near Kingston, on limestone, Feb. 12, 1927; along Black River, on earth, no. 7551.

New to Jamaica. This neat little moss, previously known only from the Dominican Republic and Florida, is an interesting addition to the Jamaican flora.

Aloinella apiculata Bartram, sp. nov. Fig. 2.

Dioica; caespitosa, caespitibus densiusculis, fuscescentibus. Caulis brevissimus, dense foliosus, simplex. Folia sicca incurvo-adpressa, humida erecto-patentia, rigida, e basi brevi lingulata, sensim acuta, apiculata, ad 2 mm. longa, marginibus inferne erectis, superne late inflexis, prope apicem denticulatis; costa applanata, dorso superne grosse papillata, ventre dense filamentosa; cellulae basilares rectangulares, parietibus fuscescentibus, superiores irregulariter transverse-elongatae, parietibus incrassatis. Folia perichaetialia minora, marginibus erectis, costa angustiori, sparse filamentosa; seta 10–12 mm. longa, rubra, laevissima; theca erecta, cylindrica, fusca, deoperculata 2 mm. longa; peristomii dentes breves, pallidi, erecti, dense papillosi, fere ad basin divisi, hic illic constricti, corona basilari ad 70μ alta; operculum conico-rostratum, 1.5 mm. longum; annulus 0; sporae 8–10μ fuscidulae, laevissimae.

TYPE: Vicinity of Arntully, Nov. 1, 1928, *C. R. Orcutt*, 6802. Very distinct from *A. catenula* Card., of Mexico, in the leaf apex, which is apiculate by the excurrent costa (not rounded and helmet-shaped).

ORTHOTRICHACEAE

Zygodon Reinwardtii (Hornsch.) A. Br.

Blue Mountain, no. 3166. New to Jamaica. The range of this species in North America, as given in Malta's monograph (5), is limited to Mexico. This seems to be the only record of both the species and the genus in the West Indies.

CRYPHAEACEAE

Acrocryphaea Coffeae (C.M.) Par.

Newmarket, nos. 7277 and 7332; Darliston, no. 6218. New to Jamaica.

PTEROBRYACEAE

Pireella filicina (Hedw.) Card.

Vicinity of Arntully, no. 7062; Stony Valley River Gully, no. 5891. Apparently an uncommon species. It is sometimes difficult to separate from

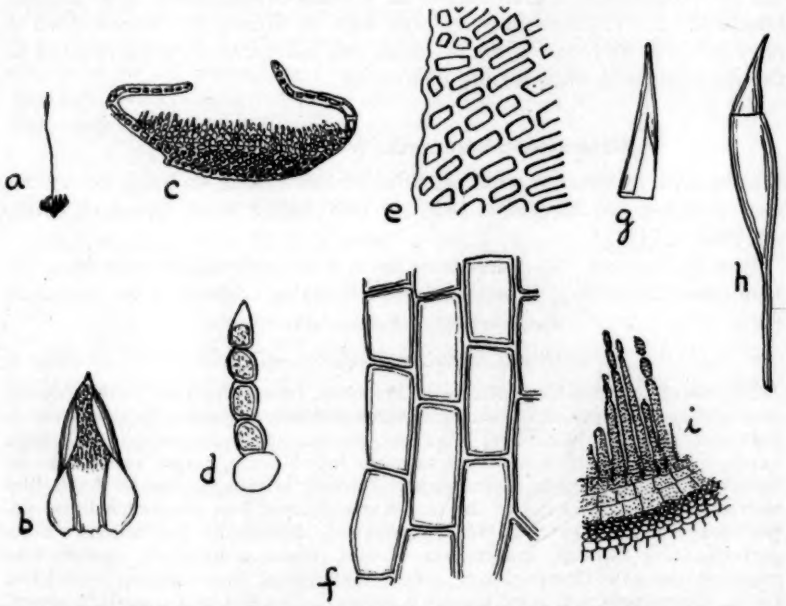

Fig. 2.—*Aloinella apiculata* Bartr., sp. nov.: *a*, plant ×1; *b*, leaf ×16; *c*, upper part of leaf in cross section ×80; *d*, costal filament ×400; *e*, upper leaf cells and margin ×400; *f*, basal leaf cells ×400; *g*, calyptra ×9; *h*, capsule ×9; *i*, part of peristome ×160.

Pterobryum angustifolium, but usually may be distinguished by the broader, more ovate branch leaves, which are deeply excavate under the apex, and by the shorter, oval cells of the upper part of the leaf. The leaves are also more inclined to be wrinkled and rugose when dry.

Pireella cavifolia (Card. & Herz.) Card.

Vicinity of Arntully, nos. 2764a and 5680a; Stony Valley River Gully, no. 5894. An interesting addition to the Jamaica flora. Previously known only from the type locality in Vera Cruz, Mexico.

METEORIACEAE

Pipillaria imponderosa (Tayl.) Broth.

Vicinity of Arntully, no. 2767; Blue Mountain Peak, no. 5305; Morce's Gap, no. 5573; Stony Valley River Gully, no. 5895. New to Jamaica.

Aerobryopsis longissima (Doz. & Molk.) Fleisch.

Aerobryopsis mexicana Card.

Vicinity of Arntully, no. 2832a. New to Jamaica. This collection is typical of the species in all respects. I am therefore well content to follow Cardot's opinion (3, 4) that *A. mexicana* and *A. longissima* are conspecific. Apparently *A. longissima* is exceedingly rare in North America, and known only from a single collection in Mexico and the one listed above from Jamaica.

NECKERACEAE

Homalia glabella (Hedw.) Mitt.

Moy Hall, no. 6832. A frequent species. The sporophyte characters have not, I think, been noted. The following description was made from plants in good fruit:

Seta slender, red, about 14 mm. long; capsule inclined, short-ovoid, 1.75 mm. long; lid conic-rostrate, oblique, as long as the urn; peristome teeth finely cross-striate, basal membrane of inner peristome about $\frac{1}{3}$ the height of the teeth, segments equalling the teeth, keeled, widely split along the median line, cilia one, appendiculate; spores smooth, 10–13μ.

Pinnatella jamaicensis Bartr.

Since the publication of this species (1) I have had an opportunity to compare the Jamaica plants with a specimen of *P. piniformis* (Brid.) named by Bescherelle (*Duss* 342 from Guadeloupe). That they are clearly distinct is unquestionable. The broadly rounded branch leaves of *P. jamaicensis* are in bold contrast to the sharply acute branch leaves of *P. piniformis*.

PILOTRICHACEAE

Pilotrichidium callicostatum (C.M.) Besch.

Many of the numerous collections of this species are from aquatic or subaquatic habitats to which the plants seem to be especially partial.

Diploneuron Bartr., gen. nov.

Pilotrichidia Besch. forsan affine, sed costis finis ad apicem folii in subulam longam acutam confluentibus.

Diploneuron connivens Bartr., sp. nov. Fig. 3.

Dioicum?; caespitosum, caespitibus sat densis, viridibus, haud nitidis. Caulis repens, hic illic radiculosus, irregulariter ramosus, ramis ad 1 cm. longis. Folia sicca erecto-patentia, saepe flexuosa, humida horride patula, e basi brevi oblongo-lanceolata, concava, acuminata, 3–4 mm. longa,

marginibus erectis, ubique minutissime crenulatis; costae binae prope medium folii, superne marginales, ad apicem in acumen attenuatum subulatum confluentes; cellulae superiores irregulares, saepe elongatae, parietibus incrassatis, sinuosis, circa 5μ latae et 12–25μ longae, hic illic bistratosae, basilares latiores, laxae, alares haud distinctae. Folia perichaetialia erecta, ad 2.5 mm. longa, caulinis sat similia sed celluis basilaribus laxioribus,

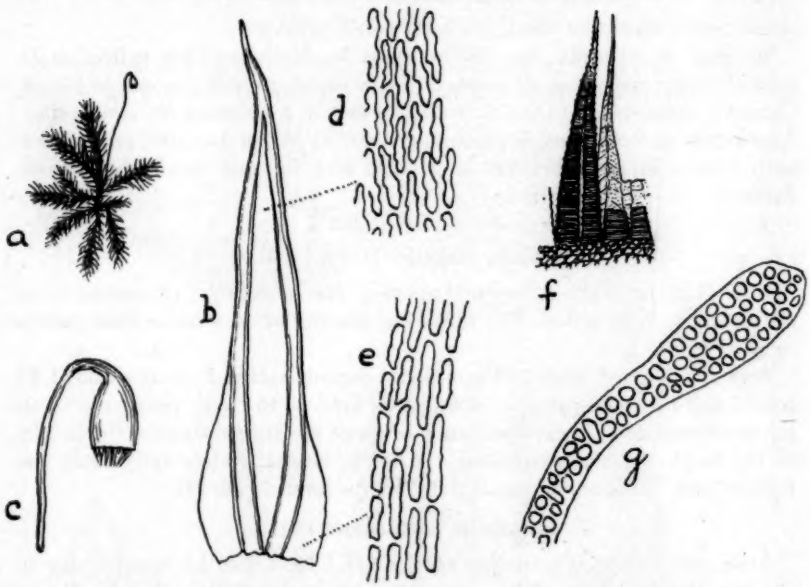

Fig. 3.—*Diploneuron connivens* Bartr., sp. nov.: *a*, plant ×1; *b*, leaf ×24; *c*, capsule ×9; *d*, upper leaf cells ×400; *e*, basal leaf cells ×400; *f*, part of peristome ×80; *g*, margin of upper part of leaf in cross section ×400.

rectangularibus, hyalinis; seta circa 2 cm. longa, laevissima, rubra; theca nutans, oblonga, fusca, 1.5 mm. longa; peristomium magnum, dentibus fuscis, trabeculatis, linea media exaratis, endostomio luteo, processibus carinatis, papillosis; calpytra sporogonii immaturi pallida, sparse pilosa; sporae laevissimae, 12–14μ.

Lumsden, St. Ann's Parish, 1928, *C. R. Orcutt* 6087 (type); Schwallenburgh, St. Ann's Parish, no 3942b.

I know of no other moss in which the costae become marginal in the upper half of the leaf and coalesce at the apex in a thickened, subulate point. Although similar to *Pilotrichidium* in sporophyte characters, the new genus is clearly unique in leaf structure.

In commenting upon this plant my friend M. Thériot suggested that it might be placed in the Pilotrichaceae. I feel that this is based on sound judgement and have adopted the suggestion, rather than follow my first inclination to include the genus in Hookeriaceae.

HOOKERIACEAE

Lepidopilum Mulleri (Hampe) Mitt.

Booby Woods, Moy Hall, nos. 6876 and 6930; vicinity of Arntully, no. 5774. New to Jamaica.

THUIDIACEAE

Anomodon Wrightii C.M.

Vicinity of Arntully, no. 3840. The above is the only gathering of this species that I know of since the original collection in Cuba by Wright. The slender, julaceous branches and entire leaves may be constant characters, but it comes uncomfortably close to *A. attenuatus* (Hedw.) Huben.

Anomodon rostratus (Hedw.) Schp.

Vicinity of Arntully, no. 3185; Westphalia (Cedar Hurst), no. 3762; Blue Mountain, no. 2854. New to Jamaica.

Thuidium minutulum (Hedw.) Bry. eur.

Thuidium Wrightii Jaeg.

Moy Hall, no. 6892; vicinity of Farm Hill, no. 3671. Abundantly represented in Jamaica by numerous collections in rich fruit. The two numbers listed above are representative. I fail to find any distinguishing characters at all in *T. Wrightii* Jaeg. Like *Anomodon rostratus*, *Campylium chrysophyllum*, and *Tortula agraria*, the range of *T. minutulum* (Hedw.) includes the southeastern United States, Cuba, and Jamaica.

AMBLYSTEGIACEAE

Platyhypnidum aquaticum (Hampe) Fleisch.

Stony Valley River Gully, no. 5877. New to Jamaica.

BRACHYTHECIACEAE

Scleropodium purum (Hedw.) Limp.

Cinchona, 1928, no. 5492c. Apparently introduced from Europe.

Rhynchostegium argute-serratum Bartr., sp. nov. Fig. 4.

Autoicum, gracilescens, caespitosum, caespitibus densis, depressis, viridibus, nitidiusculis. Caulis elongatus, parce fusco-radiculosus, repens, irregulariter pinnatim ramosus, ramis patulis, haud complanatis, cum foliis ad 2 mm. latis, breviter attenuatis. Folia ramea patula, ovato-lanceolata, acuminata, concaviuscula, ad 1 mm. longa marginibus basi leviter recurvis, superne erectis, ubique argute serratis; costa supra medium folium parum superans; cellulae superiores rhomboideo-lineares, circa 7–8μ latae, laevissimae, basin versus laxiores, alares haud distinctae. Folia perichaetialia erecto-appressa; seta tenuis, laevissima, rubra, circa 1.5 cm. longa; theca oblonga, inclinata, 1.3 mm. longa, sub ore constricta, aetate nigrescens, exothecii rete laxo, e cellulis rectangularibus, peristomium typicum; operculum e basi conica longe et oblique subulatum; sporae laevissimae, 15μ

Farm Hill, no. 3749a; Moy Hall, no. 6875; Booby Woods, Moy Hall, nos. 6957, 6962 (type).

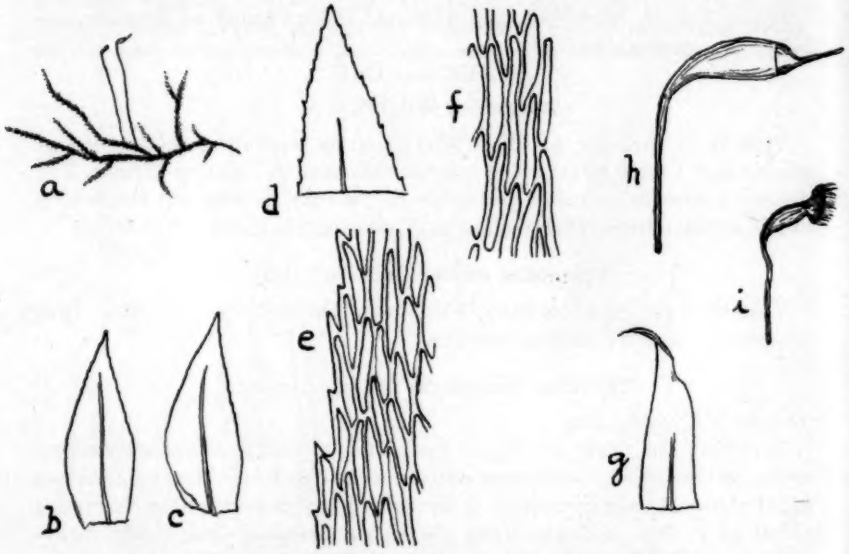

Fig. 4.—*Rhynchostegium argute-serratum* Bartr., sp. nov.: *a*, plant ×1; *b*, *c*, leaves ×30; *d*, apex of leaf ×80; *e*, upper leaf cells and margin ×400; *f*, basal leaf cells ×400; *g*, perichaetial leaf ×30; *h*, moist capsule ×9, *i*, dry capsule ×9.

A rather slender, delicate species for the genus. It may be distinguished from *R. scariosum* (Tayl.) by the vivid green color, less finely pointed leaves, shorter areolation, and sharply serrate margins. The deep red setae are also characteristic.

ENTODONTACEAE

Platygyriella jamaicensis Bartram, sp. nov. Fig. 5.

Autoica; gracilis, lignicola, caespitosa, caespitibus mollibus, densis, pallide viridibus, nitidiusculis. Caulis repens, fragilis, hic illic sparse sed longe fusco-radiculosus, subpinnatim ramosus, ramis 1–1.5 cm. longis. Folia erecto-patentia, ovato-lanceolata, concava, breviter acuminata, ecostata vel brevissime bicostata, ad 1.4 mm. longa, marginibus integerrimis, superne erectis, inferne anguste recurvis; cellulae lineares, pellucidae, infimae laxiusculae, ad angulos paucae, laxae, subquadratae vel rectangulares, omnes laeves. Folia perichaetialia erecto-patentia, integerrima; seta 4–6 mm. longa, tenuis, laevissima; theca erecta, oblongo-cylindrica, deoperculata ad 1.4 mm. longa, fusca; exostomii dentes subulato-lanceolati, fusci, superne grosse papillosi, inferne transverse striolati; endostomium fuscidulum, corona basilari humili, processibus anguste linearibus, papillosis: operculum conico-rostratum, ad 0.4 mm. longum; sporae 15–20μ, luteae, minutissime punctulatae.

TYPE: Newmarket, Dec. 12, 1928, *C. R. Orcutt* 7263.

Although the group of cells at the leaf angles is small, lax, and poorly defined, as contrasted with the distinct group of quadrate alar cells in *P. helicodontoides* Card., the peristome structure is in close accord. As the sporophyte characters are of prime importance in this group I feel that the Jamaican plants may be safely placed here.

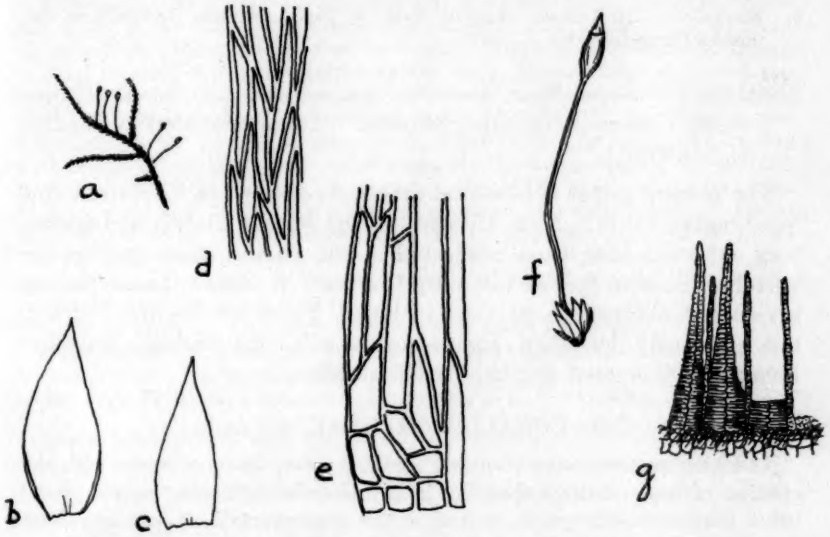

Fig. 5.— *Platygyriella jamaicensis* Bartr., sp. nov.: *a*, plant ×1; *b*, *c*, leaves ×30; *d*, upper leaf cells and margin ×400; *e*, basal angle of leaf ×400; *f*, sporophyte ×9; *g*, part of peristome ×160.

M. Thériot is in accord with me in thinking that the genera included by Brotherus in the subfamily Pylaisioideae, under Hypnaceae, with the possible exception of *Homomallium*, would find a more congenial resting place in Entodontaceae, between which family and Hypnaceae it evidently occupies a transitional position.

POLYTRICHACEAE

Atrichum angustatum (Brid.) Bry. Eur. var. **Mulleri** (Schp.) Bartr. comb. nov.

Atrichum Mulleri Schp.

Farm Hill, nos. 3367 and 3392; Portland Gap, no. 5413. For remarks on this see the note on page 361 of Honduran Mosses (2).

Oligotrichum erosum (Hampe) Lindb.

Blue Mountain, nos. 2910 and 2911. New to Jamaica.

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ZOOLOGY.—*Some West American sea anemones.*[1] OSKAR CARLGREN, University of Lund, Sweden. (Commuincated by WALDO L. SCHMITT.)

The present paper is based on material collected in California and Washington by Mr. E. F. Ricketts of the Pacific Biological Laboratory, who has long been interested in the Pacific Coast marine invertebrates. Two species taken by Professor T. Gislén, Lund, during a visit to California in 1931 are included. Three species are, I think, not previously described. Instead of the sub-tribe Protostichodactylinae, I have erected a tribe, Corallimorpheae.

Tribe CORALLIMORPHEAE, new name

As I have pointed out previously (1924, p. 180), I cannot agree with the opinion of some authors that the family Corallimorphidae, as well as all other Protostichodactylinae, belong to the Madreporaria. If we place them together, we must suppose that in the Protostichodactylinae the skeleton is lost or never has been developed. The first hypothesis, I think, we can leave out of consideration, because no traces of a skeleton have been found in the Protostichodactylinae, most of which live in shallow water, especially on coral reefs. On the other hand, supposing that the Protostichodactylinae never have been provided with a skeleton, we must consider them as descendants of forms from which the Actiniaria, as well as the Madreporaria, have arisen, for the supposition that the Madreporaria originate from the Protostichodactylinae is hardly probable. Moreover, we cannot indicate to which family of Madreporaria the latter group is allied. For my part, I am more inclined to consider the Protostichodactylinae as having developed parallel to the Madreporaria and the Protantheae (s. str.) among the Actiniaria having relations to both these groups. Perhaps an order, Corallimorpharia, equal to the Actiniaria and Madreporaria, should be erected for the Protostichodactylinae, but for the present I prefer to place them as a group, Corallimorpheae, among the Actiniaria. The name Protostichodactylinae is misleading, because on the one hand forms with the tentacles

[1] Received August 15, 1935.

not arranged in radial series must be referred to the Protostichodactylinae, and on the other that the so-called Stichodactylinae are not descendants of this group. I divide the Actiniaria then into five tribes: Protantheae (s. str.), Corallimorpheae, Ptychodacteae, Endocoelantheae, and Nynantheae.

Family CORALLIMORPHIDAE

Corynactis californica n. sp.

Diagnosis.—Sphincter elongated weak. Tentacles large, especially those belonging to the exocoels. Endocoel-tentacles in each radius 2–5; 2 siphonoglyphs, little differentiated, and two pairs of directives (always?). Longitudinal muscles of the mesenteries rather weak. Macrocnidae of the column (38) 43–53×11–12μ rather common those of the heads of the tentacles 68–83×12–14μ, those of the actinopharynx 34–42×10 (11)μ, those of the filaments partly 76–86×24–26μ, partly 38–60×12–17μ; elongated cnidae with distinct basal part to the spiral thread in the column partly 43–48×10μ (few), partly 14–25×2.5–5μ (common), those of the heads of the tentacles 35–62×4–6μ and 29–34 (53)×4.5–5μ, those of the actinopharynx 26–29 ×3.5–4μ those of the filaments partly 33–43 (48)×8.5–10μ, partly 22–29 ×6–7μ. Spirocysts (spirocnidae) of the column rather sparse, 19–24×2.5–3.5μ, those of the heads of the tentacles 24×2–about 60×5μ, those of the actinopharynx 20–26×2.5–3μ.

Color in formalin.—Column brown, other parts uncolored.

Dimensions of the largest specimen.—Largest breadth and length 1.3 cm.

Occurrence.—California, Monterey Bay 6–8 fms., June 3, 1934, 6 specimens; June 11, 1934, 1 specimen. Holotype, U. S. N. M. Cat. No. 43060.

The exterior agrees with that of other *Corynactis* species. The endocoel-tentacles varied in each radius between 2 and 5. In a specimen pierced by a Gephyrean, probably swallowed alive by the sea anemone, the number of the endocoel-tentacles in each radius was as follows: 5, 3, 2, 5, 2, 4, 2, 4, 2, 4, 2, 3, 2, 2, 2, 2, 4, 2, 4, 2, 5, 2, 4, 5, 2, 4, 2, 4, 3, 4, 2, 3, 2, 4, 3. Between each of these radii and inside the outermost endocoel-tentacles one large exocoel-tentacle was situated. The sphincter was very elongated and rather weak (fig. 1), the actinopharynx provided with numerous high longitudinal ridges. There were 2 slightly differentiated siphonoglyphs. The mesenteries were, in the sectioned specimen, 72 in the middle of the actinopharynx, 34 on one side, 38 on the other; 10 pairs and 3 single mesenteries were perfect; 2 pairs were directives. Moreover, the anatomy of the species agrees with that of other species of *Corynactis*. The measurements of the cnidae and the heads of the tentacles have been made on the largest specimen, taken June 3. I have called the large broad capsules macrocnidae, as they seem to agree with those of the Zoantharia (compare Seifert 1928). The more elongated capsules (c, c_1, capsules Carlgren, 1928, p. 131) seem to be of the same appearance as those figured by Möbius (1866, Pl. 1, figs. 5, 6) of *Caryophyllia*. The basal part of the spiral thread reminds one of that of a penicillus, but the terminal thread, at least 10 times as long as the capsules, seems to be provided with very small bristles, not figured in fig. 2. There were no zooxanthellae in the endoderm.

It is very difficult to give good diagnoses of the species of *Corynactis*, as they agree very much in their structure. The species cannot be identical with the West Indian *C. bahamensis* and *C. myrcia*. if Duerden's (1900, p. 182) statement of the arrangement of the tentacles of the latter is correct, and probably not with *C. carnae*, which is unknown on the west coast of Central America and has not been taken north of Guaytecas Islands on the west coast of South America.

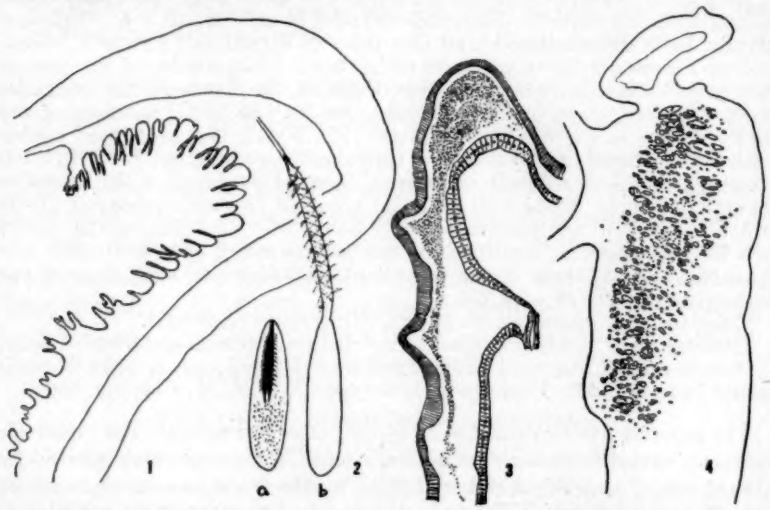

Fig. 1.—*Corynactis californica*. Sphincter. Fig. 2.—*Corynactis californica*. Cnidae: *a*, unexploded; *b*, exploded. The basal part and a little piece of the long terminal thread are figured. Fig. 3—*Amphianthus californicus*. Sphincter. Fig. 4.—*Stephanauge annularis*. Sphincter.

Tribe NYNANTHEAE

Family EDWARDSIIDAE

Edwardsia californica (McMurrich)

Edwardsiella californica McMurrich, Proc. U. S. Nat. Mus. **44**: 551, fig. 1. 1913.

Diagnosis— Physa well developed. Scapus with 8 rows of rather large nemathybomes polygonal. Tentacles 16. Pennons of the macrocnemes on cross-sections elongated with about 30–40 folds, not especially high, branched in the inner and especially in the outer part, with a palisade-like arrangement in the middle. Outer lamellar part of the macrocnemes in the reproductive region attached to the pennon rather close to its center. Parietal muscles very well developed, fan-like or more rounded, with about 8–10 branched folds on either side of the main lamella. Extension of the parietal muscles on the column normal. Nematocysts of the actinopharynx partly 29–34×2.5–3μ (numerous spirulae), and partly 24–31×about 5μ (probably penicilli, considerably fewer); those of the nemathybomes partly 115–153×6.5–7μ, and partly 72–77×2.5μ.

Dimensions.—Length 2.2 cm., breadth 0.3 cm.

Occurrence.—Balboa, California. Littoral. T. Gislen, 1931.

The figure given by McMurrich of a pennon and a parietal muscle agrees very well with what I have seen from the sections through the upper part of the reproductive region; the folds of the pennons in our specimen were somewhat fewer, those of the parietal muscles somewhat more numerous, but the appearance of the muscle-folds showed good agreement in both specimens. McMurrich mentions that the nemathybomes stand in two or three rows in the proximal end of the scapus. Certainly this arrangement was caused by contraction; in our specimen the scapus was provided with only 8 rows of nemathybomes. The specimen was a female.

Family HALCAMPOIDIDAE

Harenactis attenuata Torrey

Herenactis attenuata Torrey, Proc. Wash. Acad. Sci. **4**: 384, pl. 24, figs. 4, 5, text-figs. 16, 17. 1902.

Occurrence.—Newport Bay, California, low water, sand. T. Gislen, 1931, several specimens.

I have measured the cnidae of a large specimen. The nematocysts of the column were very numerous, 8–14×1.5–2μ; those of the tentacles numerous, rodlike, 17–22×1.5–2μ; those of the actinopharynx 24–27×2.5μ (spirulae), and 19–22×3–4.5μ (penicilli); those of the filaments 16–24×4–5μ penicilli—2 rodlike nematocysts 19–22×2.5μ, spirulae?). Spirocyst of the tentacles 10×1–19×2μ.

Family HALCAMPIDAE

Halcampa duodecimcirrata (M. Sars)?

Halcampa duodecimcirrata M. Sars. Carlgren, K. Vet. Akad. Handl., **(25) 10**: 38, pl. 5, figs. 1–5 pl, 6, figs. 1, 2. Stockholm, 1893. Danish Ingolf Exped. **(5) 9**: 119, pl. 4, fig. 8. 1921. Verril, Rept. Canadian Arctic Exped. 1913–18, P. G: 120, pl. 21, figs. 1, 2, 2a, var. *nitida*, p. 121.

Dimensions of the largest specimen.—Length 1.7 cm., breadth of its lower part 0.2, of its upper 0.3 cm. Length of the tentacles 0.2 cm. Dimensions of the smallest specimen: Length 1.2 cm., breadth 0.25 cm.

Occurrence.—Pysht, Washington, June 26, 1930, 2 specimens.

The column was broader in the distal than in the proximal end, the physa contracted, the scapus in its lower part somewhat incrusted with sand. I cannot decide whether there were real tenaculi here, as I have sectioned only the upper part of a specimen. Here no tenaculi were present. The tentacles, in number only 10, were robust and, in the contrasted state, somewhat acuminated. The sphincter had the same size and appearance as that of other *Halcampa* species. There were 20 mesenteries, 10 of which had well developed pennons and were probably perfect—the inner organs were not well preserved. The mesenteries of the sixth pair, as well as the dorsolateral and lateral pairs of the second order were imperfect; the ventrolateral pairs of the second order were absent. The cnidae agree rather well

with those of *farinacea*. The nematocysts of the scapus were 11–12× about 1.5μ (not numerous); those of the scapulus 11–13×2–2.5μ; those of the tentacles 12×2μ (very sparse); those of the actinopharynx 19–24×(4.5)–5μ (probably penicilli). Spirocysts of the scapulus very numerous, about 14×1.5–25μ; those of the tentacles 14×1–1.5–31×2–2.5μ.

It is very difficult to give good diagnoses of the species of *Halcampa* and it is possible that *duodecimcirrata* and *farinacea* are identical species but probably not *chrysanthellum*, as the tentacles of this species, according to Stephenson's figure 3, pl. 2 (1928), are conical, while those of *duodecimcirrata* are cylindrical. I have never seen the tentacles of the latter species so acuminated as in *chrysanthellum*, though I have examined many specimens of the former which lived for a long time in my aquaria.

The species of the genus *Halcampa* live, it seems, only in the arctic, subantarctic, and boreal regions; at least there are no species from tropical seas. The largest species occur in the Arctic and this raises the question of whether *H. arctica* is not an ancestor of *duodecimcirrata* which often has 8–10 tentacles in the boreal region. If so, there is nothing astonishing in the fact that *duodecimcirrata*, which Verrill records from the east coast of North America—his variety *nitida* had also 10 tentacles—occurs in the North Atlantic as well as in the North Pacific. We have, then, a parallelism with *Tealia* (*Urticina*) *felina*, the variety *coriacea* (or *tuberculata*) of which occurs in both these seas and the ancestor of which certainly is *T. felina crassicornis* (compare Carlgren 1934, p. 349).

Cactosoma arenaria Carlgren

Cactosoma arenaria Carlgren, Arkiv f. Zool. (23A.) **3**: p. 39, fig. 36. Stockholm, 1931.

Occurrence.—Monterey Bay, California, 6–8 fms., June 3, 1934, 1 specimen.

The specimen was provided with a physa, the scapus with tenaculi and incrustations. The tentacles were 24, agreeing with the number of mesenteries. The nematocysts of the scapulus (capitulum) were 8–10×1μ, those of the tentacles 12–13× about 1.5μ; those of the actinopharynx partly 24–29×3.5–4.5μ (probably penicilli), and partly 14–15× about 1.5μ (rare, often curved, probably spirulae). The spirocysts of the tentacles were 14–29 ×1.5–3μ, thus showing a good agreement with the cnidae of the type specimen.

Family NORMATHIIDAE

Amphianthus californicus n. sp.

Diagnosis.—Pedal disc very wide. Column smooth, without tubercles, thin. Only one cinclis, not situated on a tubercle issuing from the directive chamber (sometimes absent?) Sphincter strong, alveolar, consisting of very small meshes, in its upper part occupying the greater part of the meosgloea, in its lower gradually diminishing. Tentacles to about 100, rather short, the inner more than twice as large as the outer ones. Actinopharynx with about

14 longitudinal ridges. One siphonoglyph (always?). Mesenteries at the limbus about twice as many as those at the margin. A single directive pair (always?). More than 6 pairs of perfect mesenteries. Arrangement of the mesenteries irregular. Reproduction probably also by tearing of the limbus. Nematocysts of the column 17–20×3.5–4 (4.5)μ (penicilli), and 19–24×2.5–almost 3μ (probably spirulae); those of the tentacles 17–22 (28)×3.5 (5)μ (penicilli), 12–14×2.5μ (probably penicilli), and 19–26×2.5μ (spirulae); those of the actinopharynx 17–20.5×3.5 (penicilli), 20–22×2–2.5μ (probably spirulae); those of the acontia 26–31×4–4.5 (5)μ (spirulae). Spirocysts of the tentacles to about 48×6μ.

Color in alcohol.—Yellowish, around the mouth a brownish annulus.

Dimensions.—The largest specimen was 1.3 cm. high, the breadth of the oral disc 1.2 cm., the folded pedal disc considerably broader; another sectioned specimen 0.8 cm. high and 0.6 cm. broad, the pedal disc considerably broader.

Occurrence.—Monterey Bay, California; C.Y. Rock, June 11, 1934, 12 specimens. Some of these attached to a Hydrocoral. Holotype, U. S. N. M. Cat. No. 43061.

The pedal disc was very broad and mostly rather strongly folded, the column thin and smooth, with weak transverse furrows due to contraction. No cinclis was observed in cross-sections of a smaller specimen, but on sections of a piece of the column of the largest specimen (fig. 3) corresponding to the directive chamber I have found a cinclis almost wholly excavated from the endoderm. This cinclis was not situated on a distinct tubercle. The tentacles, in the largest specimen about 98, in the smaller specimens fewer, were rather short, especially the outer ones, which were less than half as large as the inner tentacles. The oral disc was wide with visible insertions of the mesenteries. Seven specimens had a single, rather broad siphonoglyph. I have not examined the smallest specimens. The actinopharynx of the largest specimens was provided with about 14 distinct and some more weakly developed longitudinal ridges.

The ectoderm of the column was low, with numerous gland cells, the mesogloea rather thin, the sphincter (fig. 4) long, broad in its upper part, gradually diminishing toward the pedal disc, and at the same time approaching the ectoderm, with very fine muscle meshes and wholly separated from the endodermal muscles of the column. The longitudinal muscles of the tentacles and the radial muscles of the oral disc were ectodermal, normally developed and with a palisade-like arrangement. The ectoderm of the actinopharynx was somewhat thicker than that of the column, the ridges mostly thickenings of the ectoderm. The cilia of the siphonoglyph was longer than in the other part of the actinopharynx.

The mesenteries were about twice as numerous as the tentacles. In a specimen with 52 tentacles I counted about 110 mesenteries at the limbus. A sectioned specimen had 9 pairs of perfect mesenteries, including a pair of directives. Judging from the insertions of mesenteries on the oral disc, there were more than 20 perfect mesenteries in the largest specimen. The pennons and the parietobasilar muscles were very weak in the sectioned specimen,

which seems to be sterile. As I have not wished to destroy the largest specimen, I cannot give any information as to the distribution of the generative organs which may be developed in it. The ciliated streaks of the filaments were well developed, as were also the thick acontia. The nematocysts of the tentacles and acontia were measured in 2 specimens.

The species agrees rather closely with *A. dohrni*, as well as with a new species from Drontheim fjord, but is certainly distinct.

Stephanauge annularis n. sp.

Diagnosis.—Pedal disc clasping stems of *Balticina* and forming an annulus around the stem. Column smooth, 1+1 cinclides on distinct tubercles. Sphincter strong, but short, reticular-alveolar, its proximal end truncate. Tentacles of ordinary length to about 96, the inner considerably longer than the outer ones. Two deep siphonoglyphs. Mesenteries probably fewer in the proximal part than at the margin, at any rate not more numerous; 48 pairs of mesenteries, 6 pairs perfect, 2 pairs of directives. All mesenteries, with the probable exception of the directives, fertile. Acontia? Nematocysts of the actinopharynx 15–18×3.5–4μ (penicilli); those of the filaments 14–17×3.5–4μ (penicilli). Spirocysts of the tentacles 19×2.5–36×5.5(6)μ.

Dimensions.—Largest specimen about 1 cm. broad, greatest height about 1.5 cm.

Occurrence.—Monterey Bay, California, on *Balticina*, 70 fms., June 26, 1930, several specimens, badly preserved. Holotype, U. S. N. M. Cat. No. 43062.

The pedal disc encircled stems of *Balticina*, therefore the Actinia, when separated from its host, has the appearance of an annulus, from which a

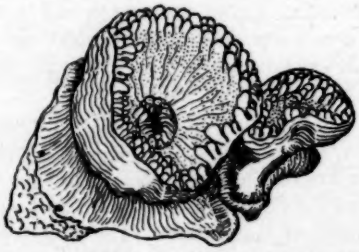

Fig. 5.—*Amphianthus californicus*, natural size.

low cylinder arises. The specimens occurred in groups, in which they stand very close to each other. The mesogloea of the smooth column was thick, the ectoderm lost. There were 1+1 cinclides in the best preserved specimen. The conical tentacles were about 96, in some specimens the outer part of the oral disc was radially furrowed. Two more closely examined specimens had 2 deep siphonoglyphs situated perpendicularly to the stem of *Balticina*.

Owing to the bad preservation of the specimens, a perfect description of their anatomy cannot be given. The sphincter was strong, reticular-alveolar, not elongated, with rather large meshes (fig. 5). The actinopharynx was

provided with longitudinal ridges caused by the swellings of the mesogloea, in the smaller, sectioned specimen 12, in the largest about twice as many. The mesogloea of the actinopharynx was thick.

The pairs of mesenteries were in one specimen 48 in the upper part, in another about 48. I cannot decide with certainty how many were present at the pedal disc, but probably they were fewer here or present perhaps in the same number as at the margin; at any rate, they were not more numerous at the limbus. Two sectioned specimens had 2 pairs of directives; 6 pairs were perfect. The longitudinal muscles of the mesenteries were weak, somewhat stronger on the directives. All mesenteries were fertile, with the probable exception of the directives. The filaments of the mesenteries were very poorly preserved, mostly dissolved; the whole coelenteric cavity was filled up by the testes. I have not found any acontia; probably they were few in number. As to the nematocysts of the tentacles and column I am not able to give any information, as the ectoderm of these organs was almost entirely lost.

Family METRIDIIDAE

Metridium senile (L.) var. **fimbriatum** (A. E. Verrill)

Occurrence.—Sitka, August 2, 1932, 1 specimen; Whale Island near Sitka, August 17, 1932, 1 specimen.

I have examined the nematocysts of the acontia in both specimens. The Penicilli were 41–50×5μ and 54–60×5μ respectively; the spirulae, 43–58, mostly 50–53×4–4.5μ and 58–62×4–4.5μ respectively. The specimens were respectively 0.8 and 0.4 cm. high, the breadth of the pedal disc 0.9 and 0.55 cm.

I take the opportunity to rectify a lapsus in my paper *Some Actiniaria from Bering Sea and arctic waters* (1934, p. 353). Where I have written "var. *marginatum*" read "var. *fimbriatum*."

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ZOOLOGY.—*Revision of the bathypelagic prawns of the family Acanthephyridae, with notes on a new family, Gomphonotidae.*[1] FENNER A. CHACE, JR., Museum of Comparative Zoology. (Communicated by WALDO L. SCHMITT.)

Owing to difficulties at this time in the publication of these observations in monographic form as was the original intention, it has seemed advisable to present an abstract of that data in the form of a key to the species of the family with one important reference for each species, together with the synonyms of each. Inasmuch as many of these forms are cosmopolitan, it is deemed unnecessary to discuss the distribution of the group at this time.

The material covered has been drawn from the collections in the Museum of Comparative Zoölogy and the U. S. National Museum made by the U. S. Steamers *Blake* and *Albatross* and the auxiliary ketch *Atlantis* of the Woods Hole Oceanographic Institution.

This opportunity is taken to acknowledge the invaluable assistance offered to me by the staffs of the Museum of Comparative Zoölogy and the U. S. National Museum, without which this paper would have been impossible. I wish to thank especially Dr. Hubert Lyman Clark, Dr. Elisabeth Deichmann, Dr. Thomas Barbour, and Dr. Henry B. Bigelow of the Museum of Comparative Zoölogy and Dr. Waldo L. Schmitt, Dr. Mary J. Rathbun, and Mr. Clarence R. Shoemaker of the U. S. National Museum.

The Acanthephyridae may be defined as that group of the Decapoda Natantia in which the first two pairs of pereiopods or "walking legs" are chelate, similar, of moderate size, and with an undivided carpus; the last three pairs of pereiopods are neither chelate nor abnormally long; all the pereiopods are provided with an exopod; there is no lash on the exopod of the first maxilliped; and the mandibles are imperfectly cleft.

The seven genera and 59 species and varieties listed by de Man in 1920 are here reduced to six genera and 44 species.

The genus omitted is *Gonatonotus*, of which there is but one species, *G. crassus* A. Milne Edwards, 1881. Although only two specimens of this aberrant form have heretofore been recorded, it has been my privilege to examine no less than 13 specimens, many of them from the Philippine region, despite the fact that the species had not been previously recorded from the Pacific. An examination of the mouthparts disclosed that the mandible is composed of but one lobe and

[1] Received August 27, 1935.

the exopod of the first maxilliped is provided with a long lash very similar to that found in the Pandalidae. Inasmuch as this character completely excludes this prawn from the Acanthephyridae, and the undivided carpus of the second pair of pereiopods prevents uniting it with the Pandalidae, it is proposed that this form be placed in a separate family. Since the name *Gonatonotus* is preoccupied for a genus of Parthenopid crabs (White, Proc. Zool. Soc., London, **15**: 58, 1847), I suggest the name **Gomphonotus**[2] for the genus of prawns, and the family may then be known as the **Gomphonotidae.**

Eleven species not examined by the author have been marked with an asterisk (*) in the key below.

KEY TO THE GENERA OF THE ACANTHEPHYRIDAE

1. Exopods of at least the third maxillipeds and first pair of pereiopods foliaceous and generally rigid; outer margin of antennal scale usually armed with a series of spines; telson not truncate at tip, but ending in a sharp point; eyes large and well pigmented....Genus 6. *Oplophorus*
   None of the exopods of the pereiopods foliaceous or rigid.....2
2. Last four abdominal somites, at least, carinate along dorsal midline.. 3
   Sixth abdominal somite never dorsally carinate.....4
3. No straight ridge or carina running entire length of lateral surface of carapace from orbit to hind margin along median lateral line; hind margin of hepatic furrow not cut off abruptly by an oblique ridge or carina; incisor process of mandible toothed for its entire length..... .....Genus 1. *Acanthephyra*
   Carapace decorated with at least one straight carina traversing the lateral surface from hind margin of orbit to posterior edge of carapace; hind margin of hepatic furrow abruptly cut off from branchial region by an oblique carina; anterior half of incisor process of mandible unarmed.. .....Genus 2. *Notostomus*
4. Ischial and meral joints of pereiopods very broad and much compressed laterally.....Genus 3. *Ephyrina*
   Pereiopods normal.....5
5. Eyes very small and poorly pigmented; anterior margin of first abdominal somite entire, not toothed; telson terminating in a truncate, spinose tip.....Genus 4. *Hymenodora*
   Eyes very large and well pigmented; anterior margin of first abdominal somite armed with a distinct lobe or tooth overlapping hind margin of carapace; telson terminating in a sharp-pointed end-piece laterally armed with spines.....Genus 5. *Systellaspis*

[2] γομφος, νοτος.

Genus 1. ACANTHEPHYRA A. Milne Edwards, 1881

KEY TO THE SPECIES OF ACANTHEPHYRA

1. Posterior third, at least, of carapace not dorsally carinate.....2
   Carapace dorsally carinate throughout its length.....13
2. Integument thin and soft.....3
   Integument hard and firm.....7
3. Carina supporting branchiostegal spine not reaching to posterior half of carapace.....4
   Carina supporting branchiostegal spine reaching almost or quite to hind margin of carapace.....6
4. Rostrum very high and laterally compressed to a thin crest; small spine on third abdominal somite (See: Balss, 1925, p. 262).....
   .....*A. tenuipes* (Bate,1888)*
   (=*Tropiocaris tenuipes* Bate, 1888)
   Rostrum depressed, not thin and high.....5
5. Large, laterally compressed spine on third abdominal somite reaching to posterior third of fifth somite (See: Lenz and Strunck, 1914, p. 327)..
   .....*A. brevirostris* Smith, 1885.
   (=*Hymenodora duplex* Bate, 1888)
   No spine on third abdominal somite (See: Kemp, 1906, pp. 19 and 23)
   .....*A. rostrata* (Bate, 1888)*
   (=*Hymenodora rostrata* Bate, 1888)
6. Rostrum little more than half as high as long (See: Balss, 1925, p. 264)
   .....*A. indica* Balss, 1925.*
   (=*Acanthephyra* sp. de Man, 1920)
   Rostrum higher than long (See: Balss, 1925, p. 262).....
   .....*A. cucullata* Faxon, 1893.
7. Telson dorsally sulcate on proximal portion.....8
   Telson dorsally ridged on proximal portion.....12
8. Carina supporting branchiostegal spine very prominent and reaching to anterior margin of branchial region.....9
   Carina supporting branchiostegal spine, if present, short and obscure..
  10
9. Rostrum less than half as long as carapace (See: Balss, 1925, p. 261)..
   .....*A. curtirostris* Wood-Mason, 1891.
   (=*A. acutifrons* Bate, 1888, part)
   Rostrum more than three-fourths as long as carapace (See: Bate. 1888, p. 736).....*A. media* Bate, 1888.
   (=*A. media* var. *obliquirostris* de Man, 1916)
10. Eyes minute, very much narrower than eyestalks (See: Alcock, 1901, p. 80).....*A. microphthalma* Smith, 1885.
    (=*A. longidens* Bate, 1888)
    Eyes normal, slightly broader than eyestalks.....11

11. Branchiostegal spine supported by a short carina (See: Stephensen, 1923, p. 44).....*A. purpurea* A. Milne Edwards, 1881.
(=*Miersia agassizii* Smith, 1882; *A. sica* Bate, 1888; *A. acanthitelsonis* Bate, 1888; *A. kingsleyi* Bate, 1888; *A. rectirostris* Riggio, 1900; *A. purpurea*, var. *multispina* Coutière, 1905; *A. parva* Coutière, 1905; *A. haeckeli* Thiele, 1905; *A. batei* Stebbing, 1905)

Branchiostegal spine minute and supported by neither carina nor ridge (See: Balss, 1925, p. 256).....*A. sanguinea* Wood-Mason, 1892.

12. No carina supporting branchiostegal spine (See: de Man, 1920, p. 61) .....*A. armata* A. Milne Edwards, 1881.

Prominent carina supporting branchiostegal spine (See: Wood-Mason and Alcock, 1894, p. 156).....*A. fimbriata* Wood-Mason, 1894.
(=*A. armata* var. *fimbriata* Wood-Mason, 1894; *A. armata* (part) of many authors)

13. First abdominal somite dorsally carinate.....14

First abdominal somite not dorsally carinate.....16

14. Hepatic spine on carapace (See: Balss, 1925, p. 260).....
.....*A. corallina* (A. Milne Edwards, 1883)
(=*Notostomus corallinus* A. Milne Edwards, 1883; *Acanthephyra valdiviae* Balss, 1914)

No hepatic spine on carapace.....15

15. Telson dorsally grooved (See: Balss, 1925, p. 261).....
.....*A. acutifrons* Bate, 1888.

Telson distinctly ridged on proximal half (See: Balss, 1925, p. 257)....
.....*A. carinata* Bate, 1888.

16. Telson dorsally ridged.....17

Telson dorsally grooved.....19

17. Rostrum armed dorsally almost to tip (See: Faxon, 1895, p. 162)....
.....*A. approxima* Bate, 1888.

Distal half of rostrum dorsally unarmed.....18

18. Second abdominal somite not dorsally carinate (See: Kemp, 1906, p. 21).....*A. pulchra* A. Milne Edwards, 1890.*

Second abdominal somite dorsally carinate (See: Balss, 1925, p. 258)..
.....*A. eximea* Smith, 1884.
(=*A. brachytelsonis* Bate, 1888; *A. edwardsi* Bate, 1888; *A. angusta* Bate, 1888)

19. Integument firm and pubescent (See: Balss, 1925, p. 259).....
.....*A. kempi* Balss, 1925.*

Integument thin and membranous (See: de Man, 1920, p. 69).....
.....*A. sibogae* de Man, 1916.

Genus 2. NOTOSTOMUS A. Milne Edwards, 1881.

KEY TO THE SPECIES OF NOTOSTOMUS

1. First two abdominal somites not dorsally carinate; dorsal carina of

carapace not denticulate on posterior two-thirds of its length; only one complete longitudinal carina on carapace 2

All abdominal somites dorsally carinate; dorsal carina of carapace denticulate for practically its entire length; two or more complete longitudinal carinae on lateral surface of carapace 3

2. Integument soft but firm; sixth abdominal somite more than twice as long as fifth (See: Balss, 1925, p. 267) ..... *N. vescus* Smith, 1886. (=*Acanthephyra brevirostris* Bate, 1888; *Acanthephyra batei* Faxon, 1895; *Notostomus batei* Balss, 1925)

Integument extremely thin and fragile; sixth abdominal somite once and a half as long as fifth (See: Balss, 1925, p. 266) .. *N. mollis* (Smith, 1882) (=*Meningodora mollis* Smith, 1882; *Hymenodora mollis* Bate, 1888; *Notostomus fragilis* Faxon, 1895)

3. No semi-carina on posterior half of lateral surface of carapace immediately below the post-orbital 4

A semi-carina on posterior half of lateral surface of carapace immediately below the post-orbital 5

4. Only two longitudinal carinae on lateral surface of carapace (See: Bate, 1888, p. 829) ..... *N. murrayi* Bate, 1888.*

Three longitudinal carinae on lateral surface of carapace (See: A. Milne Edwards, 1881, p. 7) ..... *N. gibbosus* A. Milne Edwards, 1881.*

5. Four longitudinal carinae on posterior half of lateral surface of carapace 6

Five longitudinal carinae on posterior half of lateral surface of carapace; a median lateral carina at base of rostrum 9

6. A median lateral carina at base of rostrum (See: A. Milne Edwards, 1881, p. 8) ..... *N. elegans* A. Milne Edwards, 1881.*

No median lateral carina at base of rostrum 7

7. Carina along lower margin of rostrum continuous with post-orbital (See: Balss, 1925, p. 268) ..... *N. perlatus* Bate, 1888. (=*N. brevirostris* Bate, 1888)

Carina along lower margin of rostrum not continuous with post-orbital .. 8

8. Post-orbital and post-antennal carinae nearly parallel (See: Bate, 1888, p. 830) ..... *N. japonicus* Bate, 1888.*

Post-orbital and post-antennal carinae sharply divergent behind hepatic region (See: Smith, 1886 p. 676) ..... *N. robustus* Smith, 1885. (=*N. beebei* Boone, 1930)

9. Dorsal carina of carapace straight along central portion and not very high (See: Balss, 1925, p. 269) ..... *N. westergreni* Faxon, 1893.

Dorsal carina of carapace very high and arched 10

10. Rostrum not reaching end of antennal scale (See: Bate, 1888, p. 826) ..... *N. patentissimus* Bate, 1888.*

Rostrum reaching considerably beyond end of antennal scale (See: Balss, 1925, p. 268) ..... *N. longirostris* Bate, 1888. (=*N. atlanticus* Lenz, 1914)

Genus 3. EPHYRINA Smith, 1885.

Ephyrina benedicti Smith, 1885 (See: Balss, 1925, p. 269)
(=*Tropiocaris planipes* Bate, 1888; *Ephyrina hoskyni* Wood-Mason, 1891; *Ephyrina bifida* Stephensen, 1923)

Genus 4. HYMENODORA G. O. Sars, 1877.

KEY TO THE SPECIES OF HYMENODORA

1. Integument smooth, soft and membranous; rostrum not reaching beyond tips of eyes in adults (See: Balss, 1925, p. 270)..... .... *H. glacialis* (Buchholz, 1874)
(=*Pasiphae glacialis* Buchholz, 1874; *Hymenodora gracilis* Smith, 1886; *H. glauca* Bate, 1888; *H. mollicutis* Bate, 1888)

Integument rugose, soft but not particularly membranous; rostrum exceeding eyes in length and reaching to end of antennular peduncle in adults (See: Rathbun, 1904, p. 28)..... *H. frontalis* Rathbun, 1902.

Genus 5. SYSTELLASPIS Bate, 1888.

KEY TO THE SPECIES OF SYSTELLASPIS

1. Abdomen not dorsally carinate on any somite; rostrum about one-third as long as carapace (See: Balss, 1925, p. 245)..*S. braueri* (Balss, 1914)
(=? *S. echinurus* Coutière, 1911; *Acanthephyra braueri* Balss, 1914; *S. densispina* Stephensen, 1923)

Abdomen carinate on third and fourth somites; rostrum more than half as long as carapace..... 2

2. Hind margins of fourth and fifth abdominal somites crenate on either side of the median spine (See: Balss, 1925, p. 242)..... ..... *S. debilis* (A. Milne Edwards, 1881)
(=*Acanthephyra debilis* A. Milne Edwards, 1881; *Miersia gracilis* Smith, 1882; *Acanthephyra debilis* var. *europoea* A. Milne Edwards, 1883; *Acanthephyra gracilis* Smith, 1886; *S. bouvieri* Coutière, 1905; *S. debilis* var. *indica* de Man, 1920)

Hind margins of fourth and fifth abdominal somites not crenate on either side of the median spine..... 3

3. A sharp longitudinal carina near lower margin of carapace (See: Balss, 1925, p. 244)..... *S. cristata* (Faxon, 1893)
(=*Acanthephyra cristata* Faxon, 1893)

No sharp carina near lower margin of carapace..... 4

4. Sixth abdominal somite and anterior portion of telson smoothly rounded dorsally (See: Faxon, 1896, p. 162)..... *S. affinis* (Faxon, 1896)
(=*Acanthephyra affinis* Faxon, 1896)

Sixth abdominal somite and telson deeply grooved along dorsal midline (See: Bate, 1888, p. 758)..... *S. lanceocaudata* Bate, 1888.

Genus 6. OPLOPHORUS A. Milne Edwards, 1837.

KEY TO THE SPECIES OF OPLOPHORUS

1. Second, third, and fourth abdominal somites terminating in a long spine; no spine at postero-lateral angle of carapace (See: A. Milne Edwards, 1883, Pl. 30)..... *O. spinicauda* A. Milne Edwards, 1883.
(=*O. foliaceus* Rathbun, 1906; *Hoplophorus foliaceus* Kemp, 1913; *Acanthephyra anomala* Boone, 1927)

Third, fourth and fifth abdominal somites terminating in a long spine.. 2

2. No spine at postero-lateral angle of carapace..... 3

A distinct spine at postero-lateral angle of carapace; outer margin of antennal scale spinose..... 4

3. A distinct barb on inner margin of antennal scale near the tip; outer margin of same spinose (See: Balss, 1925, p. 249)..... ..... *O. grimaldii* Coutière, 1905.
(=*Hoplophorus grimaldii* Courtière, 1905; ? *Acanthephyra pellucida* A. Milne Edwards, ms. fide Perrier. See Kemp, p. 66, 1906)

No barb on inner margin of antennal scale; outer margin of same devoid of spines (See: de Man, 1931, p. 369)..... ..... *O. novae-zeelandiae* de Man, 1931.*

4. The median lateral carina at base of rostrum is subparallel to the dorsal margin; distal sixth of antennal scale unarmed; rostrum distinctly longer than antennal scale; small spine on lower margin of pleuron of first abdominal somite (See: Kemp, 1913, p. 63)..... ..... *O. gracilirostris* A. Milne Edwards, 1881.
(=*O. longirostris* Bate, 1888; *Hoplophorus smithii* Wood-Mason, 1891; *Hoplophorus typus* (part) Balss, 1925)

The median lateral carina at base of rostrum converges posteriorly toward the dorsal midline; distal fourth of antennal scale unarmed; rostrum rarely reaching beyond tip of antennal scale; no spine on lower margin of pleuron of first abdominal somite (See: Bate, 1888, p. 762)..... ..... *O. typus* H. Milne Edwards, 1837.
(=*O. brevirostris* Bate, 1888)

Note: Since this paper was written, a specimen of *Bentheocaris stylorostratis* Bate has come to hand. It was collected with a closing net in 900 fathoms just west of the Gulf Stream off the coast of New Jersey on September 1, 1935 by the *Atlantis* of the Woods Hole Oceanographic Institution. This specimen is 57 mm. long, the largest of the five recorded specimens, and is apparently an adult female. An examination of the mouth-parts discloses that this species belongs in the genus *Acanthephyra* near *A. cucullata* Faxon. This same conclusion was reached previously by Dr. W. T. Calman and published in Union S. Africa Fish. Mar. Biol. Survey **4(3)**: 14. 1925.

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ZOOLOGY.—*Nomenclatorial changes involving California polychaete worms.*[1] OLGA HARTMAN, University of California. (Communicated by MARY J. RATHBUN.)

In the course of a study of the marine annelid fauna of California certain revisions in the current names of a number of species appear necessary:

Cirriformia nom. nov. pro *Audouinia* Quatrefages, 1865, nec A. Costa. *Audouinia* was used by Costa in 1834 and 1851 for a genus of amphipods and is now considered a synonym of *Corophium* (cf. Stebbing, 1906, p. 685). Two common species from California are (1) *Cirriformia luxuriosa* (Moore, 1904) whose range is hereby extended northward to Dillon Beach, Marin County, California, and (2) *C. spirabrancha* (Moore, 1904) known from Mendocino County (Chamberlin, 1919) south to San Diego, California (Moore, 1904).

Eteone pacifica nom. nov. pro *E. maculata* Treadwell, 1922, nec OErsted, 1843. This species described from Friday Harbor (Treadwell), was collected by Mr. C. E. Moritz and the author in 1933 at Moss Beach, San Mateo County, California.

Stylarioides dimissus nom. nov. pro *S. minuta* Treadwell, 1914, nec *Pherusa minuta* Quatrefages, 1865, which is a *Stylarioides*. Originally described from La Jolla, California, this species is now known to range northward to Moss Beach, San Mateo County, California.

Changes necessitating a shift of generic name or reduction to synonymy follow. The synonyms in each case follow the signs of equality:

[1] Received October 3, 1935.

Aphrodita castanea Moore, 1910 = *A. californica* Essenberg, 1917
Aphrodita japonica Marenzeller, 1879 = *A. solitaria* Essenberg, 1917
Acholoe fragilis (Baird) = *Lepidonotus fragilis* Baird, 1863
Acholoe leioseta (Chamberlin) = *Halosydna leioseta* Chamberlin, 1919
Acholoe pulchra (Johnson) = *Polynoe pulchra* Johnson, 1897 = ?*Halosydna succiniseta* Hamilton, 1915
Lepidonotus lagunae (Hamilton) = *Halosydna lagunae* Hamilton, 1915
Nereis vexillosa Grube, 1851 = *Mastigonereis spinosa* Kinberg, 1866
Perinereis monterea (Chamberlin) = *Nereis* (*Neanthes*) *monterea* Chamberlin, 1918
Uncinereis agassizi (Ehlers), 1868 = *Nereis notomacula* Treadwell, 1914 = *Uncinereis subita* Chamberlin, 1919
Glycera alba (Müller), 1788 = *Glycera basibranchia* Chamberlin, 1919
Glycera branchiopoda Moore, 1911 = *Glycera profundi* Chamberlin, 1919
Glycera macrobranchia Moore, 1911 = *Glycera exigua* Chamberlin, 1919
Eumida longicornuta (Moore) = *Eulalia longicornuta* Moore, 1906
Arabella semimaculata (Moore), 1911 = *Arabella munda* Chamberlin, 1919
Lumbrinereis inflata (Moore), 1911 = *Lumbrinereis cervicalis* Treadwell, 1922 = *Lumbriconereis albifrons* Crossland, 1924
Ninoe chilensis Kinberg, 1865 = *Ninoe palmata* Moore, 1903
Orbinia nuda (Moore) = *Aricia nuda* Moore, 1911 (*Aricia* sensu Savigny, 1822, nec R. L., 1817, pro Lepidoptera)
Scoloplos acmeceps Chamberlin, 1919 = *S. elongata* Johnson, 1901, nec Quatrefages, 1865
Boccardia natrix (Söderström), 1920 = *Polydora californica* Treadwell, 1914 = nec *Spio californica* Fewkes, 1889
Laonice cirrata (M. Sars), 1851 = *Spionides foliata* Moore, 1923
Laonice sacculata (Moore) = *Spionides sacculata* Moore, 1923
Nerinides acuta (Treadwell) = *Spio acuta* Treadwell, 1914
Cirratulus cirratus (O. F. Müller) = *C. cingulatus* Johnson, 1901
Ophelia magna (Treadwell) = *Ophelina magna* Treadwell, 1914
Ophelia mucronata (Treadwell) = *Ophelina mucronata* Treadwell, 1914

ZOOLOGY.—*A new coyote from Honduras.*[1] E. A. GOLDMAN, Bureau of Biological Survey.

In Central America coyotes are restricted mainly to open savanna or semi-forested areas, subject to a long dry season, along the Pacific coast as far south as Costa Rica. They do not regularly occur in the unbroken forests that cover so much of the general region, and form more or less effective barriers limiting their distribution. The discovery by the veteran collector, Mr. C. F. Underwood, of an undescribed form in an open, sterile, rocky section on the Caribbean side

[1] Received October 16, 1935.

of the continental divide in central Honduras is, therefore, of considerable interest.

Canis hondurensis sp. nov.

Honduras Coyote

Type.—From Cerro Guiñote, northeast of Archaga, on the Talanga road north of Tegucigalpa, Honduras. No. 251447, ♂ adult, skin and skull, U. S. National Museum (Biological Survey collection); collected by C. F. Underwood, August 18, 1934. X-catalogue number 27352.

Distribution.—Known only from the open country near the type locality.

General characters.—A rather small, rufescent species, with coarse, thin pelage and a short, broad skull. Similar in color to *Canis latrans dickeyi*, of the Pacific coast region of Salvador, but smaller, and skull characters, especially the shorter tooth rows and more widely spreading zygomata, distinctive. Resembling *C. l. goldmani* of eastern Chiapas, Mexico, but back apparently more heavily overlaid with black and differing in various cranial features.

Color.—Type: Top of head and back coarsely grizzled buffy grayish mixed with black, the black tending to predominate on the back; muzzle, outer surfaces of ears, flanks, fore and hind limbs rusty rufous; a short, narrow line of black hairs along middle of anterior surface of forearm; under parts sparsely clothed, the hairs light buffy across abdomen, becoming whitish on throat and inguinal region; a few inconspicuously dark-tipped hairs across under side of neck; tail above overlaid with black like back, below light buffy, giving way to black all around at tip.

Skull.—Similar in general to that of *C. l. dickeyi* but smaller, especially shorter, with more widely spreading zygomata; nasals much shorter, and broader between maxillae; palate relatively broader; audital bullae smaller; dentition similar, but maxillary and mandibular tooth rows shorter, the premolars more closely crowded. Compared with that of *C. l. goldmani* the skull is somewhat smaller, but with similarly wide spreading zygomata; frontal region broader, but rather highly arched as in *goldmani;* nasals broader between maxillae; lambdoid crest normal, not strongly projecting and broadly rounded in outline as in *goldmani;* interpterygoid fossa broader posteriorly; bullae smaller, more flattened, less distended along inner sides below; maxillary and mandibular tooth rows shorter; premolars more closely crowded; lower carnassial rather large, high and trenchant.

Measurements.—Type: Total length, 1,240 mm.; tail vertebrae, 350; hind foot, 190. An adult female topotype: 1,130; 290; 190. *Skull* (type): Greatest length, 190.3; condylobasal length, 178.2; zygomatic breadth, 100.7; breadth of rostrum (at constriction between first and second upper premolars), 30; interorbital breadth, 35.1; postorbital constriction, 39.1; breadth across mastoid processes of squamosal, 60.7; greatest length of nasals, 76; width of nasals (across middle between maxillae), 12.6; maxillary tooth row (alveoli), 77.2; crown length (outer side) of upper carnassial, 20; crown width of upper carnassial, 9.9. An adult female topotype: Greatest length, 181.5; condylobasal length, 171.9; zygomatic breadth, 107.7; breadth of rostrum, 31.4; interorbital breadth, 35; postorbital constriction, 37; breadth across mastoid processes of squamossal, 62.9; greatest length of nasals, 68.2; width of nasals, 11.4; maxillary tooth row, 74.7; crown length of upper carnassial, 19; crown width of upper carnassial, 9.7.

Remarks.—It is probable that *Canis hondurensis* will eventually require reduction to subspecific status under the widely ranging *Canis latrans*, but

in the absence of evidence of intergradation, and in view of the possibility of complete geographic isolation it seems best, meanwhile, to treat the animal as a full species.

Mr. Underwood describes the region of the type locality as open, sterile and rocky, and concerning the occurrence and habits of coyotes says: "They seem to prefer to make their dens amongst the rocks often within a league or so from cattle farms or haciendas where calves and chickens can be got. The natives resort to poison when they become too numerous. In several other parts of the country where conditions are analogous to the place where these were taken they are more or less abundant. They are very wary and difficult to shoot, but at times fall at night light hunting."

Specimens examined.—Three, all from the type locality.

ENTOMOLOGY.—*New neotropical empoascan leafhoppers.*[1] P. W. OMAN, Bureau of Entomology and Plant Quarantine. (Communicated by HAROLD MORRISON.)

This paper contains descriptions of 12 apparently new species of *Empoasca* from South America, Costa Rica, and Puerto Rico which the writer has encountered in the course of his work during the past few years. Since names have been requested for most of these it seems desirable to describe them at this time. Unless otherwise stated the illustrations accompanying these descriptions show a magnification of approximately 65 diameters.

Empoasca peregrina n. sp.

Resembling *trifasciata* (Gillette), but longer, with a black spot on apex of vertex and lacking dorsal spines. Length 4.75 mm.

External characters: General ground color pale yellowish-white. Apex of vertex with a round black spot. Posterior margin of pronotum, all of scutellum, and adjacent margins of elytra piceous to fuscous. Elytra hyaline, with a transverse smoky vitta across middle and another just before apical cross-veins, beyond cross-veins faintly smoky. Form generally more slender than that of *trifasciata*.

Male internal structures (Fig. 1, A): Lateral processes slender, in ventral view bluntly rounded apically. Dorsal spines rudimentary. Styles strongly diverging distally. Aedeagus comparatively slender, with a short projection on posterior margin. Sternal apodemes very large, rather slender and parallel sided, reaching beyond middle of 6th segment.

Described from a single specimen, the holotype male, intercepted at the Plant Quarantine inspection house at Washington, D. C., Jan. 8, 1934, in cotton lint packing from Peru. Type, Cat. No. 51283, U. S. N. M.

Empoasca rubraza n. sp.

Apparently resembling Osborn's species, *picta*, *decorata*, and *rubromaculata* in size and color but differing from them in color pattern, particularly in the two longitudinal red stripes on pronotum. Dorsal spines saber-shaped in lateral view. Length 3.1–3.3 mm.

[1] Received October 1, 1935.

External characters: Color bluish-green with contrasting red or orange-red marks. Face suffused with pale orange-red; vertex pale bluish-green with a pale orange dash next to each eye and a spot above each ocellus, these markings often irregular and poorly outlined. Pronotum with a bright orange-red stripe each side of median line, these slightly narrowed posteriorly. Elytra with elongate red stripes on each side of claval sutures, the claval stripe covering all but margins of clavus; costal submargin faintly orange tinged. Apical one-third of elytra subhyaline, veins pale and distinct. Vertex short, slightly produced medially; general form rather broad. Female genital segment impressed laterally about half way from base, posterior margin truncate or very slightly notched medially.

Male internal structures (Fig. 1, B–C): Lateral processes comparatively stout, apical portions sinuately curved, with tips directed caudad and inward. Dorsal spines broad in lateral view, slightly curved and sharply pointed; in general outline somewhat saber-shaped. Aedeagus short, portion for muscular attachment curved upward and then caudad; outline in lateral view very distinctive in the genus. Styles broadened before tips in ventral view; tips bent obliquely downward in lateral view. Sternal apodemes large, reaching beyond base of 5th segment.

Holotype male from Loreto, Prov. Missiones, Argentina, Nov. 29, 1931, A. A. Oglobin. Allotype female from the same locality, Dec. 6, 1931. Paratypes, 6 males and 13 females from the above locality and collector, taken on various dates from Nov. 25 to Dec. 10, 1931. There is also at hand 1 female from Huachi, Beni, Bolivia, September, W. M. Mann, Mulford Biological Exploration, 1921–22. Type, Cat. No. 51284, U. S. N. M.

Empoasca perelegans n. sp.

A large species with two black spots on vertex and with elytral stripes of smoky-fuscous, except apically. Length 3.5–4 mm.

External characters: General ground color pale bluish green; specimens collected late in the season (September) yellow to white. Face with a red stripe from below each ocellus to apex of clypeus, the two fused apically. Vertex with a pair of round black spots on anterior margin near median line and a transverse red stripe posteriorly. Pronotum faintly and irregularly marked with red each side of median line except posteriorly. Claval veins and claval sutures marked with smoky-fuscous; similar stripes between veins of corium before cross-veins; elytra hyaline except for smoky-fuscous stripes. Form rather slender, vertex slightly produced medially. Posterior margin of female genital segment produced and rounded, with a faint notch medially.

Male internal characters (Fig. 1, D): Lateral processes slender and tapered to sharp points. Dorsal spines stout, bifurcate apically. Aedeagus ending in a rounded, lobe-like process; below this a pair of slender, curved processes arising from posterior margin. Styles strongly diverging distally in ventral view. Sternal apodemes relatively broad, reaching to base of 5th segment.

Holotype male, allotype female, and 3 male and 27 female paratypes from San Pedro de Montes de Oca, Costa Rica, May 2, 1934, collected from *Annona cherimola* by C. H. Ballou. Other paratypes, 9 females and 1 male, collected by Mr. Ballou at the same locality Sept. 16, 1933, from *A. cherimola* and *A. muricata*. Type, Cat. No. 51285, U. S. N. M. Paratypes in collection of C. H. Ballou. There are also specimens at hand from La Ceiba, Honduras, and Vicosa, Minas Geraes, Brazil.

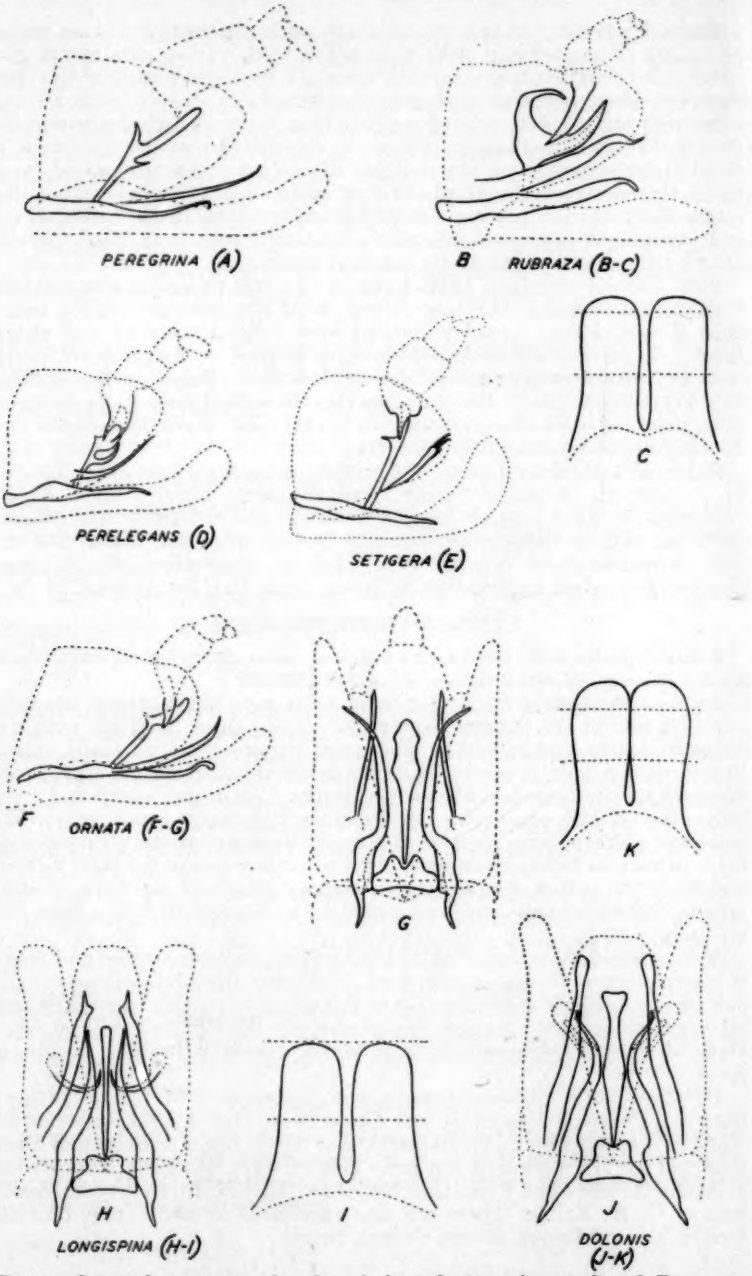

Fig. 1.—Internal structures of male. A, lateral view of genitalia of *Empoasca peregrina*. B, lateral view of genitalia; and C, sternal apodemes of *rubraza*. D, lateral view of genitalia of *perelegans*. E, lateral view of genitalia of *setigera*. F, lateral view; and G, ventral view, of genitalia of *ornata*. H, ventral view of genitalia; and I, sternal apodemes of *longispina*. J, ventral view of genitalia (×100); and K, sternal apodemes of *dolonis*.

Empoasca setigera n. sp.

A comparatively robust species with the lateral processes bearing stout spine-like setae apically and the dorsal spines short. Length 3.3 mm.

External characters: Vertex, pronotum, and scutellum greenish-yellow, marked with white areas, the most constant of which are a median dash on vertex, a transverse row of spots on pronotum anteriorly, and spots on disk of scutellum. Elytra hyaline with a green tinge. Species comparatively broad; vertex short, slightly produced medially. Female genital segment truncate posteriorly.

Male internal structures (Fig. 1, E): Lateral processes short, nearly straight, each bearing several short, stout, spine-like setae on apex and inner margin before apex. Dorsal spines broad basally, abruptly narrowing to short, slender spines. Aedeagus slender. Sternal apodemes rudimentary.

Holotype male from Loreto, Prov. Missiones, Argentina, Nov. 29, 1931, A. A. Ogloblin. Allotype female from the same locality and collector, Dec. 12, 1931. Paratypes, 50 males and 5 females from the above locality and collector, taken on various dates from Nov. 25 to Dec. 18, 1931. Type, Cat. No. 51286, U. S. N. M.

Empoasca ornata n. sp.

Pale green, marked with orange-red on head and thorax. More slender than *rubraza*, n.sp., and without the bluish coloration. Length 3.7 mm.

External characters: General ground color pale green. Face irregularly marked with orange-red; vertex with a transverse band of the same color, interrupted on median line. Pronotum and scutellum irregularly washed with orange-red. Elytra hyaline, faintly mottled with smoky brown areas especially along dorsum. Vertex slightly produced medially, form more slender than that of *rubraza*.

Male internal structures (Fig. 1, F–G): Lateral processes nearly straight, tips turned upward in lateral view. Dorsal spines blunt. Aedeagus relatively slender in lateral view, much broadened distally in ventral view. Styles strongly diverging posteriorly in ventral view; in lateral view apical portions twisted and tips somewhat knob-like. Sternal apodemes rudimentary.

Holotype male from near mouth of Rio Mapiri, Bolivia, September, Mulford Biological Exploration 1921–22. Type, Cat. No. 51287, U. S. N. M.

Empoasca longispina n. sp.

A large species without definite markings but with unusually long dorsal spines. Pygofer with several short spine-like setae on posterior margins. Length 4 mm.

External characters: Color golden green without definite markings but head and portions of thorax with a granular appearance. Apical one-third of elytra hyaline. Vertex short, very slightly produced medially.

Male internal structures (Fig. 1, H–I): Lateral processes sharply pointed, nearly straight in lateral view; in ventral view slightly bowed inward, with a blunt tooth on inner margins before tips. Dorsal spines slender and tapering to sharp points, unusually long and extending first downward and slightly cephalad and mesad, tips curved caudad and slightly upward. Aedeagus slender. Styles slender apically. Posterior margins of pygofer each with about 5 short spines which vary considerably in size and are directed mesad and caudad. Sternal apodemes reaching base of 5th segment.

The large size and lack of markings seem to make this species distinct

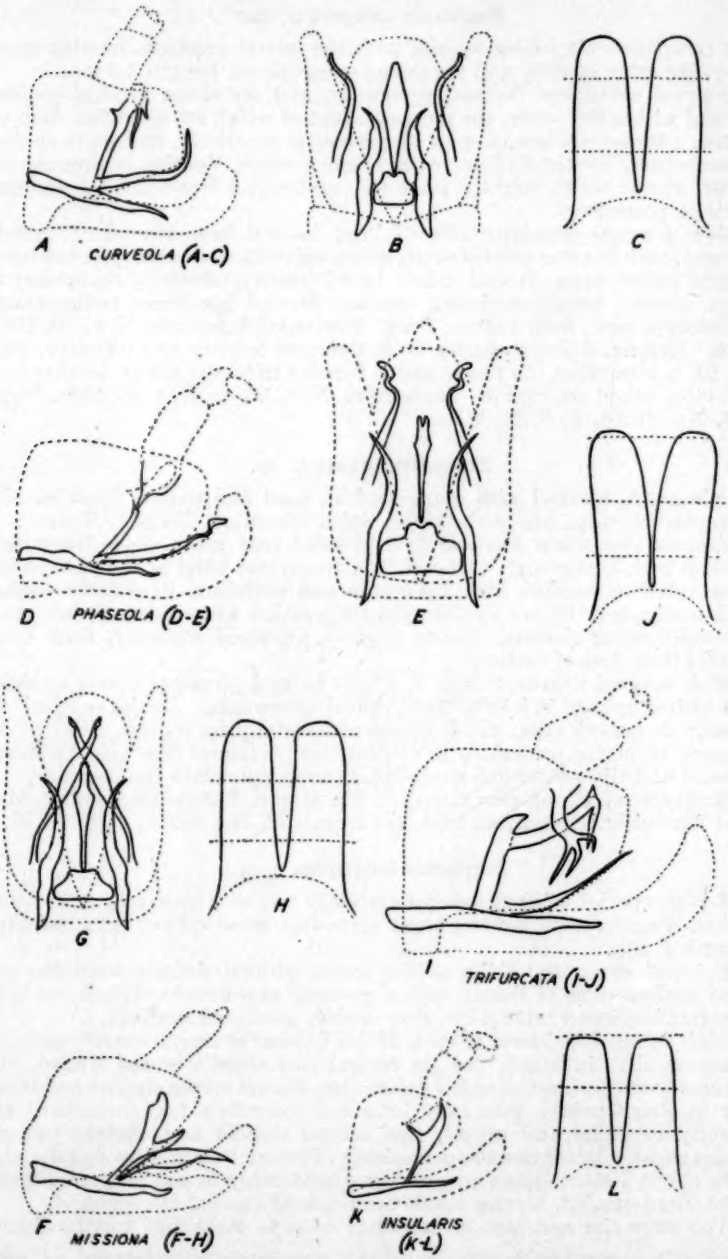

Fig. 2.—Internal structures of male. A, lateral view; and B, ventral view, of genitalia; and C, sternal apodemes of *Empoasca curveola*. D, lateral view; and E, ventral view, of genitalia of *phaseola*. F, lateral view; and G, ventral view, of genitalia; and H, sternal apodemes of *missiona*. I, lateral view of genitalia (×100); and J, sternal apodemes of *trifurcata*. K, lateral view of genitalia; and L, sternal apodemes of *insularis*.

from any of the South American forms described by Osborn. Structurally this species seems close to *salinarum* Berg,[2] but differs in coloration.

Holotype male from Loreto, Prov. Missiones, Argentina, Dec. 1, 1931, A. A. Ogloblin. Type, Cat. No. 51288, U. S. N. M.

Empoasca dolonis n. sp.

A slender species with forked dorsal spines and subtruncate lateral processes. Length 3–3.2 mm.

External characters: Color pale green to pale golden green. Ocelli circled with white. Pronotum and scutellum with white areas; elytra with a pale golden dash along claval sutures basally. Species slender, vertex well produced and rather narrow. Female genital segment truncate posteriorly.

Male internal structures (Fig. 1, J–K): Lateral processes extending caudad and slightly upward; apices flattened dorso-ventrally, in ventral view obliquely subtruncate, upper surfaces slightly concave before apices. Dorsal spines forked, but in lateral view appearing as single spines. Aedeagus broad apically in lateral view. Styles more slender apically than is usual in the genus, in lateral view bowed upward just before apices which are directed downward. Sternal apodemes large, extending to middle of 5th segment.

Holotype male from Loreto, Prov. Missiones, Argentina, Nov. 25, 1931, A. A. Ogloblin. Allotype female with the same data but collected Nov. 29, 1931. Paratypes, 4 males and 12 females from the above locality and collector, taken on various dates from Nov. 27 to Dec. 18, 1931. Type, Cat. No. 51289, U. S. N. M.

Empoasca phaseola n. sp.

A rather large, slender species without definite markings. Lateral processes sinuated apically and enlarged at tips. Length 4–4.25 mm.

External characters: Pale green to yellowish green with indefinite white areas on head and thorax. Elytra subhyaline before cross-veins, sometimes with faint golden stripes longitudinally; beyond cross-veins hyaline. Vertex well produced; general form comparatively slender. Posterior margin of female genital segment produced and rounded, with a faint notch medially.

Male internal structures (Fig. 2, D–E): Lateral processes relatively stout and straight basally, apically slender and strongly sinuated, apices enlarged and somewhat foot-shaped. Dorsal spines broad basally, abruptly tapered and ending in a slender finger-like process. Aedeagus simple, relatively slender. Sternal apodemes close together, reaching nearly to base of 5th segment, apices obliquely subtruncate.

Holotype male, allotype female, and 3 male and 30 female paratypes from San Pedro de Montes de Oca, Costa Rica, Oct. 21, 1933, collected from *Phaseolus vulgaris* by C. H. Ballou. Type, Cat. No. 51290, U. S. N. M. Paratypes in collection of C. H. Ballou.

Empoasca trifurcata n. sp.

Indistinguishable externally from small examples of *fabae* (Harris), but with the lateral processes straight and slender and the dorsal spines trifurcate. Length 3 mm.

External characters: Color pale green; head and thorax marked with the usual yellowish and white areas. Vertex slightly produced medially.

Male internal structures (Fig. 2, I–J): Lateral processes extending caudad

[2] *Hemiptera Argentina*, p. 274. 1879.

and slightly upward, gradually tapering from bases to slender, sharp-pointed apices. Dorsal spines stout, each terminating in three slender, pointed processes, of which the posterior two are bent. Aedeagus stout, extending upward, then obliquely upward and backward, and terminating in a finger-like spine which extends downward and slightly to the right. Sternal apodemes very long, reaching base of 6th segment; apices bluntly rounded.

Holotype male from Loreto, Prov. Missiones, Argentina, Nov. 29, 1931, A. A. Ogloblin. Paratype, 1 male with the same data, but collected Dec. 14, 1931. Type, Cat. No. 51291, U. S. N. M.

Empoasca curveola n. sp.

Externally indistinguishable from *trifurcata*, n. sp., but with the lateral processes strongly curved and comparatively stout. Length 3 mm.

Male internal structures (Fig. 2, A–C): Lateral processes of nearly uniform width throughout, slightly stouter basally and bluntly pointed apically, in lateral view with apical one-third bent upward, in ventral view apical one-half curved obliquely outward but with extreme tips bent caudad. Dorsal spines forked basally, each with a short, sharp spine from inner margin and a longer, slender spine directed downward and curved slightly inward. Aedeagus slightly broadened apically in lateral view, margins sinuately curved. Sternal apodemes reaching middle of 5th segment, tapering slightly from bases to apices, apices rounded.

Holotype male and 2 male paratypes from Caseros, Prov. Buenos Aires, Feb. 3, 1927, C. F. Henderson. Other paratypes, 2 males collected by Mr. Henderson at Las Heras, Prov. San Juan, Dec. 10, 1926. Type, Cat. No. 51292, U. S. N. M.

Empoasca missiona n. sp.

Externally indistinguishable from *trifurcata* but with the lateral processes swollen at middle and the dorsal spines obsolete. Length 3 mm.

Male internal structures (Fig. 2, F–H): Lateral processes slender basally, gradually becoming stouter to middle and tapering to apices, which are pointed in lateral view, but constricted on inner margins and obliquely truncate in ventral view. Dorsal spines rudimentary. Aedeagus in lateral view with a curved extension from posterior margin, this consisting of two thin structures which can be seen to diverge apically when viewed from caudal aspect. Sternal apodemes reaching nearly to middle of 6th segment.

Holotype male from Loreto, Prov. Missiones, Argentina, Dec. 14, 1931, A. A. Ogloblin. Type, Cat. No. 51293, U. S. N. M.

Empoasca insularis n. sp.

Superficially identical with *trifurcata*, but slightly smaller and without distinct dorsal spines or lateral processes. Female genital segment with posterior margin slightly produced and rounded, faintly notched medially. Length 2.5–2.75 mm.

Male internal structures (Fig. 2, K–L): Lateral processes and dorsal spines rudimentary. Aedeagus simple but relatively stout. Styles slightly turned upward apically in lateral view, in ventral view diverging posteriorly. Sternal apodemes unusually large, reaching to base of 6th segment.

Holotype male, allotype female, and 6 male and 4 female paratypes from Rio Piedras, Puerto Rico, May 20, 1932, collected by M. D. Leonard on *Annona* (spelled *Anonia*) *diversifolia*. Type, Cat. No. 51294, U. S. N. M.